Journal

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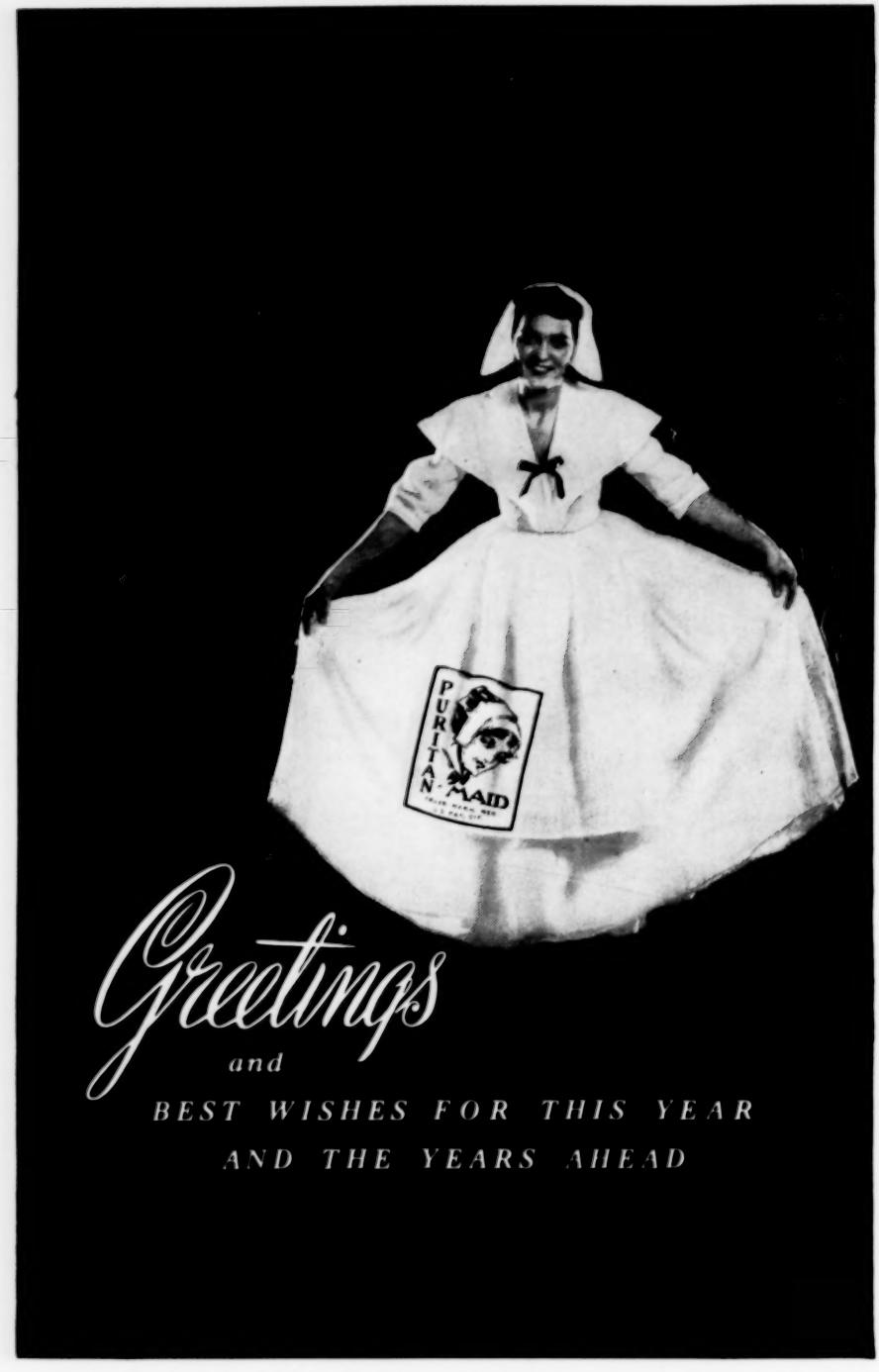

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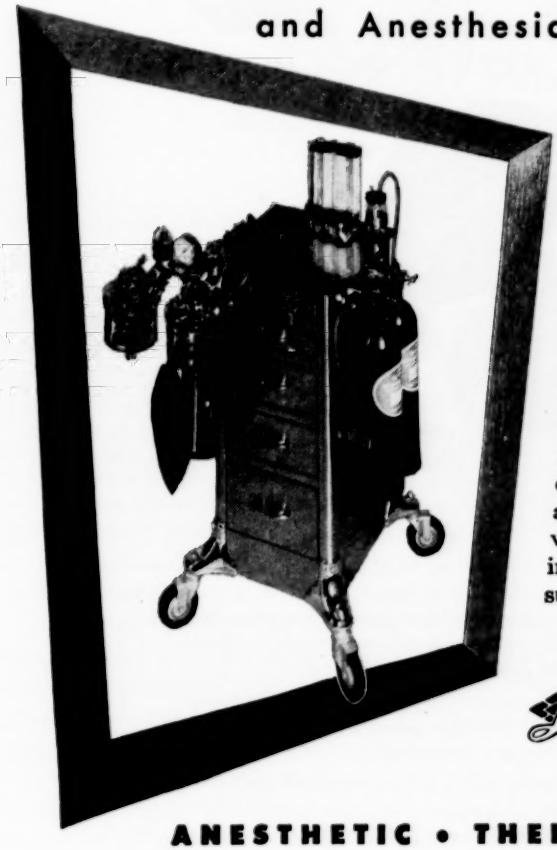

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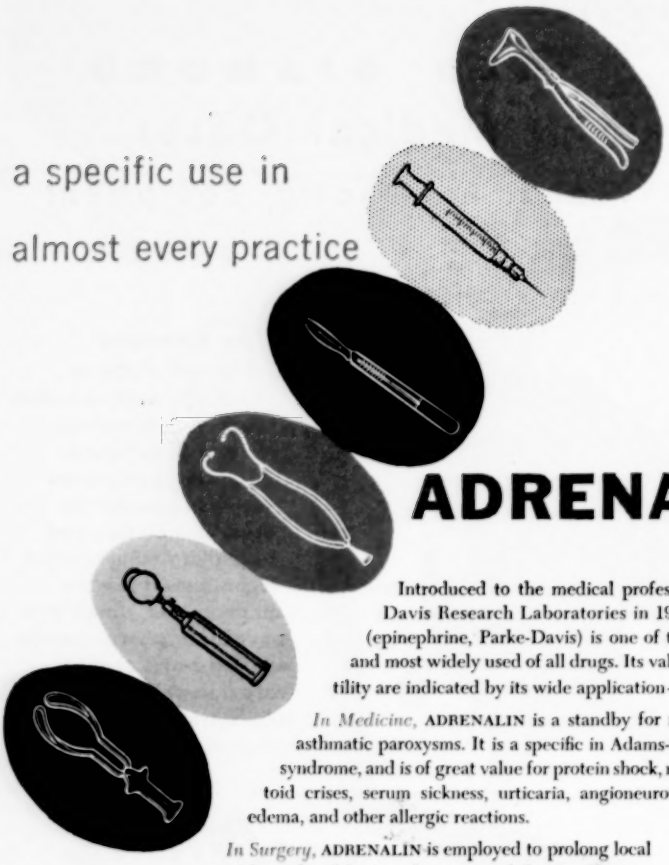

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Opinion Review

Role of the Nurse in the Recovery Room

One of the most vital and important developments in many years in hospital service has been the advent of the postanesthesia room.

During World War II nearly every large base hospital instituted a "postoperative ward." This ward was situated adjacent to the operating room suite, and was under the direction of the chief of anesthesiology. Here all surgical patients were cared for by trained personnel for a minimum of twenty-four hours.

Since the end of the war, many of our civilian hospitals have adopted this service, although in a majority of places, the "postoperative ward" has become the "recovery room." Here all postanesthetic cases are cared for under constant surveillance until they have recovered full consciousness and are stabilized. Then only is it considered they may be safely returned to their own rooms.

Previously, due to the acute nursing shortage and the large influx of surgical cases, postoperative care was inadequate, at best. Now, surgical patients are provided with safe and effective care, thereby relieving, to some extent, the nursing service on the wards and private floors. It has indeed opened up an entirely new field in nursing.

The number of personnel naturally depends on the size of the surgical service. The supervisor and staff nurses must be trained by a member of the department of anesthesia, receiving instruction on what signs to watch for, what emergency treatment they themselves may give and how to manipulate the equipment necessary to such a department. They should also be made to realize their own limitations and know when it is advisable to call for assistance from a member of the anesthesia department.

The student nurse, being under constant supervision, actually learns a great deal more about postanesthesia care than was possible formerly. I believe a majority of the students find their service in the recovery room interesting, and feel that it gives them a better understanding of the requirements of good surgical care. They learn above all to be alert and observant.

In hospitals that maintain a school of anesthesia for nurses, I feel that each student should spend a prescribed amount of time in the recovery room.

They, too, must learn the correct care of the postanesthesia patient, where such a service has undoubtedly saved many patients from near disaster. They become cognizant of the importance of the constant checking of the blood pressure, pulse, respiration and color, and above all, the value of being able to recognize any irregularity the prompt correction of which can prevent serious trouble. Since it is reasonable to expect that some of these future anesthetists will, in time, be asked to instruct graduate nurses as recovery room supervisors, it is equally important that they themselves be able to speak from actual experience; to know, not only about the nursing care, but the type of equipment, drugs and other materials used in maintaining such a department.

The members of the anesthesia department are called upon for many things, from confirmation of a suspicion of trouble, for treatment, to restarting an intravenous infusion, or just plain moral support. The recovery room has undoubtedly given anesthetists a great deal of satisfaction and peace of mind. In the not too distant future, I hope that all hospitals will be able to reap the benefits of this very fine service.—**Susan C. Prince, R.N., Wilmington, Del.**

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The Journal OF THE American Association of Nurse Anesthetists

Vol. XXI No. 4 November, 1953

Well Pleased

One of the national hospital magazines in reporting the annual meeting of the American Association of Nurse Anesthetists began its article with the statement "Well pleased with the year, their organization and their convention, the American Association of Nurse Anesthetists reelected all of their 1952-1953 officers."

Often organizations when they grow rapidly are confronted with failure on the part of their leaders to change their organizational pattern in keeping with the larger tasks. Concern with the internal problems of the organization often results in losing sight of the goal.

In many respects this association has a right to be "well pleased." In testing its progress against its stated objectives it seems that the American Association of Nurse Anesthetists has avoided some of the pitfalls that befall organizations. Its leadership and its members have avoided schisms and factions and have concentrated their efforts on working toward the objectives.

The objectives of this association as they are stated in the original certificate of incorporation are:

a. To advance the Science and Art of Anesthesiology.
b. To develop educational standards and techniques in the adminstration of anesthetics.
c. To facilitate efficient cooperation between nurse anesthetists and the medical profession, hospitals, and other agencies interested in Anesthesiology.
d. To publish periodicals and to issue bulletins from time to time to aid in the general purposes of the organization.
e. To establish and maintain a central bureau for information, for reference and assistance in matters pertaining to the Science and Art of Anesthesiology.
f. To promulgate an educational program with the object of disseminating, through proper channels, the importance of the proper administration of anesthetics.

Each member may test the present accomplishments against these stated objectives.

With the progress that has been made and will be made during the present year, we hope that the members may unanimously endorse the statement "well pleased."

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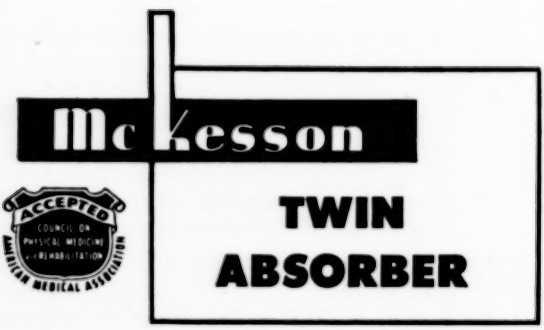

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Pharmaco-Physiological Effects of Muscle Relaxants and Their Antagonists

Robert W. Virtue, M.D.*
Denver

If this paper had been written five years ago its title would have been simply Curare and Physostigmine. Today there are many muscle relaxants and antagonists being developed as replacements for those substances, hence this rather complicated title is used. There is a reason for the change. It has been estimated that $2,000,000 worth of curare was being sold in this country in 1950, of which $60,000 was required to go to South America to obtain the raw material, to pay the natives for their labor, and to bring it back to this country and extract the active constituent in pure enough form for its use with human beings. The difference between the $60,000 and the $2,000,000 went to getting bottles, labels, and paying the salesmen and the stockholders of the companies.

Dr. Ing in England[1] has been working for years on tetra-alkyl ammonium compounds as relaxing agents, therefore some information had been obtained on such complicated structures. It was possible to make use of his knowledge after Wintersteiner and Dutcher[2] of the Squibb institute obtained the structure of curare so that it was known how far apart the two ammonium-nitrogens were in the molecule. The compounds investigated by Ing then could be compared to see whether the nitrogens were the right distance apart. Many were found to be efficacious as muscle relaxing agents. Some peculiarities were noted in that a five-carbon compound turned out to be an antidote for a six-carbon compound;[3] that is, pentamethonium would offset the relaxing properties of hexamethonium. The decamethonium (Syncurine) proved to be the best of this particular series.

The question arises: How do these compounds act? Perhaps we ought to review a little about the pharmacology of a normal muscle contraction. Normal muscle tissue at the junction with the nerve (motor end-plate) has an electrical potential and so is said to be polarized. The impulse coming along the nerve to the muscle has been found to liberate acetylcholine at the motor end-plate.[4] Ace-

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Read before the Twentieth Annual Meeting of the American Association of Nurse Anesthetists, San Francisco, Sept. 2, 1953.

*Division of Anesthesiology, Department of Surgery, University of Colorado Medical Center.

1. Ing, H. R.: Curariform action of onium salts. Physiol. Rev. **16**:527-544 (Oct.) 1936.

2. Wintersteiner, O., and Dutcher, J. D.: Curare alkaloids from Chondodendron tomentosum. Science **97**:467-470 (May 21) 1943.

3. Bovet, D.: Some aspects of relationship between chemical constitution and curare-like activity. Ann. New York Acad. Sc. **54**:407-437 (Oct. 31) 1951.

4. Foldes, F. F.; Machaj, T. S.; Hunt, R. D.; McNall, P. G., and Carberry, P. C.: Synthetic muscle relaxants in anesthesia. J.A.M.A. **150**:1559-1566 (Dec. 20) 1952.

tylcholine then effects depolarization at the muscle junction and when this muscle becomes depolarized the change in electrical activity causes the muscle to contract. Cholinesterase is normally present in the blood in quantities which enable it to rapidly inactivate the acetylcholine so that the muscle is stimulated very briefly. The muscle then becomes repolarized and is thereby brought back to its normal condition.

It is known that curare prevents the depolarization of this motor end-plate by acetylcholine. Curare does not prevent the formation of acetylcholine but curare, in some way or another, attaches itself to the motor end-plate to make a barrier to the acetylcholine. Various other compounds have been obtained which have curare-like properties. For example, the curare molecule has been modified by putting a couple of methyl groups on so that dimethyl curarine has an action which is much more potent than that of curare itself. It has a longer time of action because more time is required for the body to hydrolize the methyl groups. The mode of action at the motor end-plate of the dimethyl compound is about the same as that of curare. Flaxedil is another compound which has an action very similar to that of curare at the motor end-plate. Flaxedil has another action in the body somewhat like that of atropine although much weaker. In about one fourth of the patients who get Flaxedil the pulse rate will increase from 10 to 20 per minute.

Decamethonium or Syncurine has an action which is different from that of curare at the nerve-muscle junction. Decamethonium has the property of keeping the motor end-plate depolarized for some time. Now if the action of acetylcholine in causing muscle twitch is depolarization, then it might be asked why does not decamethonium cause a muscle twitch instead of a muscle relaxation? Those of you who have used this compound know that it does frequently cause muscle twitches; in fact, such twitching has been observed to continue as long as five minutes. Because of these twitches some practitioners have decided not to use Syncurine at all. These twitches sometimes appear to be convulsive in nature but since there is no hypoxia to the brain, no cyanosis results if the person giving the decamethonium is breathing adequately for the patient, so that it is not a true convulsion. However, muscle fasciculations following the use of Syncurine can be somewhat troublesome.

Recently a compound has been developed which acts at the motor end-plate in a fashion very similar to that of Syncurine but which has a much shorter time of action. Succinylcholine is the compound commonly known as Anectine or by other trade names. A recent article in a British journal[5] mentioned five different names. This material injected in proper dosage will cause muscle relaxation for a period of some two to three minutes, which is usually adequate for the introduction of an intratracheal tube; its effect is then fairly well worn off so that the patient can breathe spontaneously. Its use has been followed by muscle fasciculations but no re-

5. Collier, H. O. J.: Descendants of decamethonium. Brit. J. Anaesth. **25**:100-115 (April) 1953.

ports have appeared to indicate that they are as strong as those with the use of Syncurine.

Another substance has been used as a muscle relaxing agent whose effect on the motor end-plate seems to vary with the dose. This material is called Mytolon. Its use is followed by considerable salivation and bronchorrhea so that it has not had as widespread clinical use as the other two types of drugs.[6] There is some question as to its mode of continued action on the motor end-plates; perhaps sometimes it prevents the action of acetylcholine and at other times it may enhance depolarization.

Antagonists

It has been known for some years that physostigmine is an antidote to the action of curare. Physostigmine, of course, is a parasympathomimetic compound, and as might be expected, when physostigmine is injected there is a general parasympathomimetic stimulation. Perhaps one of the worst effects is the salivation which follows. Physostigmine is an antagonist to the muscular relaxation caused by curare. It has been used considerably in England, probably more than in this country because the doses of curare generally given in England are larger than the doses of curare given in this country. Physostigmine acts by preventing cholinesterase from destroying acetylcholine. Physostigmine therefore preserves acetylcholine from enzymatic hydrolysis and its pharmacologic effects can be accounted for on this basis. Its action, however, is prolonged and the side effects after the curare effect has worn off have not always been pleasant. Because of this, new drugs have been synthetized which are chemically somewhat similar to physostigmine but whose action would not have all the side effects that physostigmine has. Tensilon is one of these which has been most satisfactory to date.[7] It has been put on the market as an antagonist to curare.

Tensilon is effective in offsetting the muscle relaxing effects of curare but its action is limited to perhaps 10 minutes. If a patient therefore is overcurarized and is given Tensilon, the person giving the Tensilon may have a false sense of security because when the effect of the Tensilon has worn off the effect of curare may continue and the patient's respirations may not be adequate. If a patient's respiration is depressed and Tensilon is given, that patient should be observed for perhaps 15 to 20 minutes afterward to be sure that after the Tensilon wears off the patient can breathe adequately on his own. While Tensilon does not produce the severe side effects that physostigmine does, salivation may be troublesome. Atropine may be given with the Tensilon to offset the excess secretion. Because of the difference in mechanism of action of the curare-like compounds and the Syncurine-like compounds, it would seem that Tensilon and physostigmine might not be effective against Syncurine or succinylcholine. That is the case. In fact, these compounds are definitely antago-

6. Arrowood, J. G.: Mytolon chloride: a new agent for producing muscular relaxation. Preliminary report. Anesthesiology **12**:753-761 (Nov.) 1951.

7. Randall, L. O.: Synthetic curare-like agents and their antagonists. Ann. New York Acad. Sc. **54**:460-479 (Oct. 30) 1951.

nistic and one might even find that if he gave curare and Syncurine to the same patient, Syncurine rather than causing further muscle relaxation would offset some of the effects of curare. This should be kept in mind when using these relaxing drugs or their antagonists in combination.

Efforts have been made to obtain antagonists to succinycholine because some cases of prolonged depression of respiration have occurred after its use. Such a preparation not yet on the market commercially is termed "cholase." It has been found that cholase given to patients who have had prolonged recovery times would let them breathe fairly well.[8] Cholase is extracted from normal plasma.

Perhaps something should be said here about the mechanism of action of succinylcholine and its hydrolysis. The red blood cells contain an enzyme known as true cholinesterase; this material normally hydrolizes acetylcholine, preventing its prolonged action. The plasma contains a similar but different enzyme called pseudocholinesterase. This material is not specific for acetylcholine and will hydrolize succinylcholine. After succinylcholine is administered, it must be hydrolized by the pseudocholinesterase in order that its action should not continue. Some patients have a lower concentration of pseudocholinesterase in plasma than others. Several cases have been reported of prolonged action of succinylcholine in which analyses of plasma have shown that pseudocholinesterase in these cases has been low. Lehmann[9] reports that there is some pseudocholinesterase even in stored blood, hence administration of blood will help offset a prolonged action ofsuccinylcholine.

The amount of pseudocholinesterase in the plasma differs with different species, so that some species would be more sensitive to the action of succinylcholine than others. Members of the same species have somewhere near the same value of plasma or pseudocholinesterase. Experiments have been carried out in various animals indicating that some animals may have a definite low value of pseudocholinesterase but that after injection of cholase the pseudocholinesterase of plasma has increased so that they then were able to destroy succinylcholine rapidly.[10] Commercial preparations of antagonists to succinylcholine are not on the market yet but should be available soon.

At our institution, we had one case of delayed recovery after administration of succinylcholine. The patient had had intestinal surgery, peritonitis, and obstruction, and was being reoperated. During closure of the abdominal wall he was given succinylcholine in several intermittent doses. A total dose of 165 mg. was administered within a period of 35 minutes. Spontaneous respiration did not occur until 6½ hours later. It was suggested that intestinal trauma might have enhanced the action of the succinylcholine, and that repeated doses of succinylcholine might have had cumula-

8. Evans, F. T.; Gray, P. W. S.; Lehmann, H., and Silk, E.: Effect of pseudo-cholinesterase level on action of succinylcholine in man. Brit. M.J. 1:136-138 (Jan. 17) 1953.

9. Lehmann, H.: Succinycholine. Lancet 2:199-200 (July 31) 1952.

10. Hall, L. W.; Lehmann, H., and Silk, E.: Response in dogs to relaxants derived from succinic acid and choline. Brit. M.J. 1:134-136 (Jan. 17) 1953.

tive effects. We therefore carried out some experiments which we hoped might explain this case that we had observed.

Our work with rats indicated that in this species, at least, repeated doses of succinylcholine did have an extra effect. The second dose was followed by respiratory paralysis which was approximately twice as long as that of the first dose. The experiments also indicated that animals whose cecums had been traumatized had respiratory paralysis after the injection of a dose of succinylcholine which was approximately double that of those animals that had not been traumatized. Our results also indicated that those animals whose intestines had been traumatized and were given succinylcholine did not survive as well as those animals that were traumatized and did not have to metabolize succinylcholine at the same time.[11] Quantitatively, of course, these results can probably not be applied to human beings but it is generally recognized that any warning obtained with animal experiments can well be carried over to human beings, so that continued or repeated doses of succinylcholine, while usually well tolerated, cannot always be expected to be satisfactory. The companies which produce succinylcholine suggest that it be used cautiously in debilitated patients or in those with liver disease. To these conditions should probably be added those involving severe intestinal trauma.

11. Smith, D. L., and Virtue, R. W.: Anesthesiology, to be published.

Summary

1. Curare, dimethylcurare, and Flaxedil act by preventing acetylcholine from depolarizing the motor end-plate of muscle.

2. Decamethonium and succinylcholine act by maintaining depolarization of the motor end-plate.

3. Physostigmine antagonizes the effects of the curare-like relaxants by inhibiting cholinesterase. Tensilon is a shorter-acting antagonist of curare.

4. Reliable antagonists to decamethonium and succinylcholine are not on the market at present.

Anesthesia for Premature Babies

Betty E. Lank, R.N.*
Boston

Anesthesia for small babies who require surgery demands techniques which tax one's skill and fully justify the attention of all anesthetists. Even more exacting are the conditions which are met and which must be overcome in handling a premature infant, who is so tiny, so fragile and so immature. To anesthetize the premature baby safely calls for particularly delicate handling if the subject is to survive. Not all the small infants discussed here were actually premature in the sense that the period of gestation was short, nor did all of them weigh less than five pounds at birth. However, all of these babies weighed five pounds or less at the time of surgery.

The following report comes from an experience with anesthesia for one hundred and fifty-nine infants who came to surgery during the period from 1936 through 1951 at the Children's Medical Center in Boston.

This particular type of baby poses extremely grave problems in preoperative care, anesthesia, surgery, and postoperative care. The following conditions have been presented by these babies: (1) intestinal obstruction; (2) pyloric stenosis; (3) esophageal atresia, with tracheo-esophageal fistula; (4) imperforate anus; (5) sacrococcygeal teratoma; (6) diaphragmatic hernia; (7) incarcerated inguinal hernia. [see figures 1, 2, 3, 4, 5, 7 (A), 7 (B)].

Read before the annual meeting of the Ohio State Association of Nurse Anesthetists, April, 1953.

*Children's Medical Center.

Special Physiologic Consideration

In a matter of minutes after a baby is born, great physiologic changes take place in several of the vital organs and systems which require rapid readjustment. Only occasionally does a normal, full-term infant experience any trouble in making these readjustments, but the premature and small infant almost invariably encounters difficulties. In many ways there is a vast difference between a full-term baby and a premature infant. For the anesthetist it is important to point out these differences as they occur in the various systems of the body.

Body Temperature and Metabolism

The body weight of a full-term infant comprises about 5 per cent of that of the adult; the body surface area is approximately 15 per cent of that of the adult. In the premature infant the body surface is proportionately greater but is

poorly protected, due to the small amount of subcutaneous fat. There is a lack of vasomotor control, and also the body production of heat is at a low level. These factors make these infants highly susceptible to changes in environmental temperature and from these changes the baby must be shielded.

The Respiratory System

It is obviously essential to guard the baby against any factors such as anoxia and any type of anesthesia that would impair the central nervous system. The whole respiratory system in the premature infant is weak, due to the weakness of the rib cartilage and intercostal muscles. Because of this, quite frequently the baby is born with varying degrees of atelectasis. One often observes in immature infants during attempts at deep inspiration with crying, that the sternum and anterior chest retract, indicating diaphragmatic breathing and resistance of the lungs in attempts at inflation.

The minute volume of respirations in the newborn premature infant, based on the surface area, is quite close to the adult respirations, but is accomplished with greater effort on the part of the premature baby.

The comparison between the premature baby, the normal baby and the adult is rather crude but indicates that according to weight

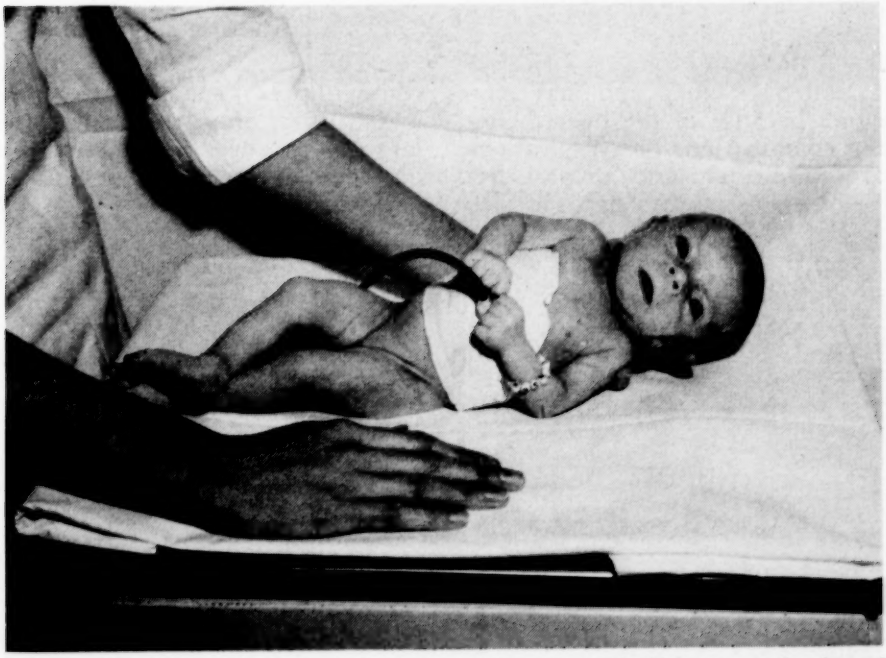

Fig. 1. This is a photograph of a baby weighing 3 pounds, 10 ounces at the time of operative correction of esophageal atresia and tracheo-esophageal fistula. Intrathoracic operation for division of the fistula and primary anastomosis of esophageal ends was performed. The baby had an excellent postoperative course and has been discharged home.

the normal baby has a vital capacity proportional to that of an adult with a minute volume two and one half times as great. This is because of the much more rapid and less deep respirations. The premature baby according to his weight and surface area has a somewhat greater tidal air with a greater volume, the result of a still more rapid respiration. The rate of respiration in these babies varies from 35 to 110 per minute with an average of 50 to 60 per minute. Tidal air of the premature infant weighing between 3 and 5 pounds is only 12 or 13 cc.

The respirations of the premature infant are almost entirely diaphragmatic and if these are hampered by the presence of abdominal distention, diaphragmatic hernia, or by conditions such as atelectasis or pneumonia, the infant has little or no respiratory reserve to fall back upon and may succumb because of the overwhelming combination. The respirations are quite often jerky or periodic; this may be due to mild anoxia and usually disappears when oxygen is given. The brain of a small baby will survive more severe episodes of anoxia than that of an adult, but anoxia must be avoided so far as possible.

Cardiovascular System

The blood volume of a newborn is proportional to that of an adult, amounting to about 8 per cent of the body weight. This is subject to change as great as one fourth of the total amount, depending upon the pulsation of the umbilical cord. The blood volume of a newborn infant at birth may be increased if the cord is not clamped until all pulsation has ceased.

The premature infant tends to have a higher pulse rate, a lower blood pressure, lower erythrocyte count, lower hemoglobin level. Yet to meet the demands of his larger body surface area he is required to have a greater cardiac

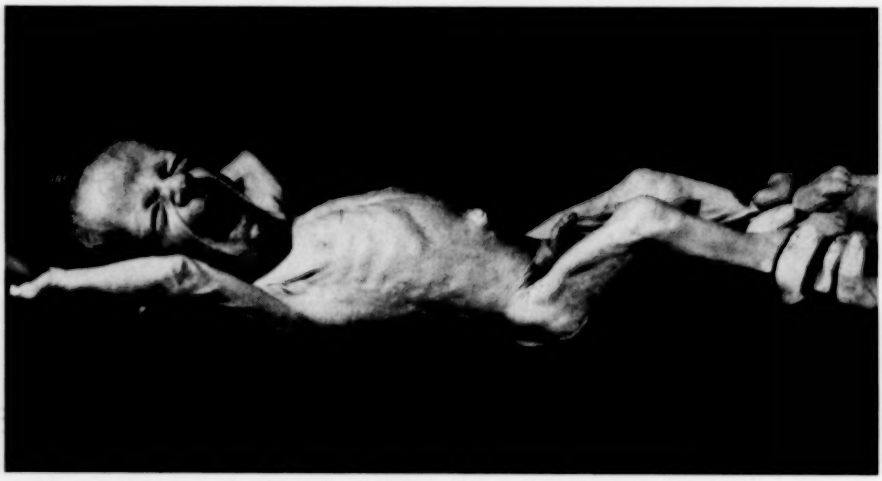

Fig. 2. Photograph of a baby weighing 4 pounds, 10 ounces who had hypertrophic pyloric stenosis. Note the dryness and flabby skin due to excessive vomiting. The baby was successfully treated by pyloromyotomy.

output, and this is made at the expense of cardiac reserve. This lower reserve plus lack of vascular control makes the premature infant susceptible to changes in the blood volume such as we see in blood loss, shock or overhydration.

The tiny baby is very prone to edema due to deficiency of plasma protein and this in turn reflects the globulin and albumin fractions. With these low deficiencies we encounter low leucocyte counts making the premature infant particularly susceptible to

FIG. 3. This is a baby weighing 2 pounds, 6 ounces who had duodenal atresia. The length of the entire abdomen is but 2½ inches. The child was successfully treated by duodenojejunostomy.

FIG. 4. This baby weighed 2 pounds, 11 ounces at the time of operation for multiple atresias of the ileum, treated by excision of the atretic area and side-to-side anastomosis of the remaining loops. Photograph taken one month after operation. Note satisfactory condition of the wound. The child was in excellent health 4 years later.

the normal baby has a vital capacity proportional to that of an adult with a minute volume two and one half times as great. This is because of the much more rapid and less deep respirations. The premature baby according to his weight and surface area has a somewhat greater tidal air with a greater volume, the result of a still more rapid respiration. The rate of respiration in these babies varies from 35 to 110 per minute with an average of 50 to 60 per minute. Tidal air of the premature infant weighing between 3 and 5 pounds is only 12 or 13 cc.

The respirations of the premature infant are almost entirely diaphragmatic and if these are hampered by the presence of abdominal distention, diaphragmatic hernia, or by conditions such as atelectasis or pneumonia, the infant has little or no respiratory reserve to fall back upon and may succumb because of the overwhelming combination. The respirations are quite often jerky or periodic; this may be due to mild anoxia and usually disappears when oxygen is given. The brain of a small baby will survive more severe episodes of anoxia than that of an adult, but anoxia must be avoided so far as possible.

Cardiovascular System

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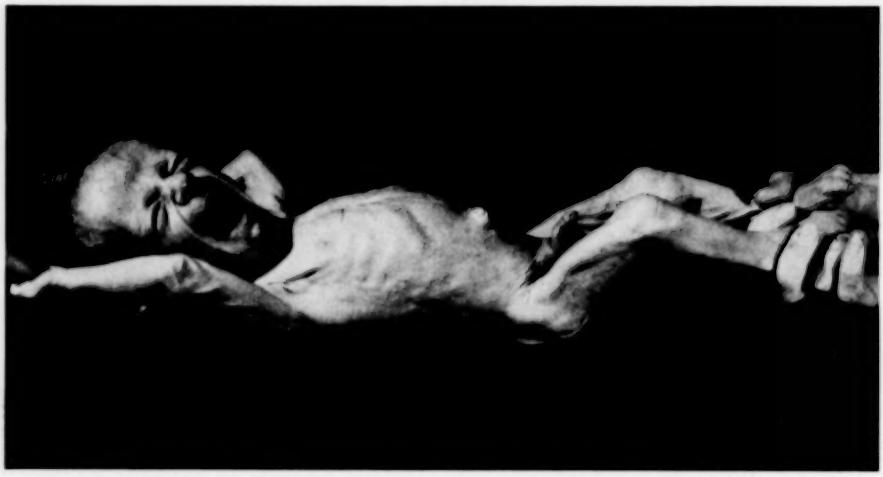

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infection. The baby may develop a hemorrhagic tendency which is due to a transient hypoprothrombinemia and thus have a low healing power in the tissues of a surgical wound. This can be prevented by the parenteral administration of Vitamin K.

Care of the Premature Infant Before Surgery

Isolation. These babies are transported to the Children's Medical Center from outside hospitals and many of them travel great distances from all over New England. In this manner they are exposed to outside atmospheres and to inexperienced personnel who have to handle and transport them, and some deterioration is unavoidable. If to these difficulties there is added some major congenital malformation which requires surgery, the combination may be insurmountable. However, if these infants are given prompt and efficient help, many of them can be carried through their trials and live to be healthy children.

Every baby requiring surgery is regarded as critically ill and is immediately placed on the danger list or put in a "grade 4" category. When he enters the hospital he is put in an "incubator" and we favor the Isolette (see figure 6). This is to be his home until he is large enough and stable enough to withstand exposure to the outside world.

The basic theory when once he is placed in the Isolette is, "Don't touch the baby any more than is absolutely necessary."

The Isolette regulates the whole environment such as heat, humidity, air circulation, oxygen and a misty atmosphere if needed. The temperature is regulated between 82 and 86 degrees for full-term babies, but for the premature baby the temperature is set at 98 degrees. Humidity is usually kept at 75 to 80 per cent. Mistogen is used in cases of tracheo-esophageal fistula and for any baby with respiratory difficulty when need-

Fig. 5. This child weighed 3 pounds, 7 ounces and had a sacrococcygeal teratoma. After removal of the mass the child weighed 2 pounds, 11 ounces. Child in excellent health and without evidence of recurrence 2 years later.

ed. This is accomplished by a supersaturated, moist atmosphere made by the spraying of droplets from a Mistogen bottle.

The mattress of the Isolette can be placed in either the Fowler's or Trendelenburg position according to the patient's need. All handling and treatment is performed through the portholes, thus minimizing the possibility of introducing infection. The surgical baby is usually turned from side to side every two hours, and all possible treatment is done at this time, avoiding any undue motion. Because of the regulated temperature inside the Isolette the babies wear no clothing, which makes for convenient observation of the baby as a whole. Provided with the Isolette bed is an ingenious method of weighing. The baby is placed in a cotton sling and attached to the scale on top of the Isolette.

When the proper time arrives for the baby to be weaned from the Isolette it is done gradually (in approximately twelve hours), but the bassinette is kept in the cubicle with the Isolette for a period of a few days, in case an emergency arises.

Special Therapy

Each of these babies presents a congenital anomaly requiring surgery, which reduces the respiratory reserve, and it is important that the respiratory system be given all possible assistance such as the administration of oxy-

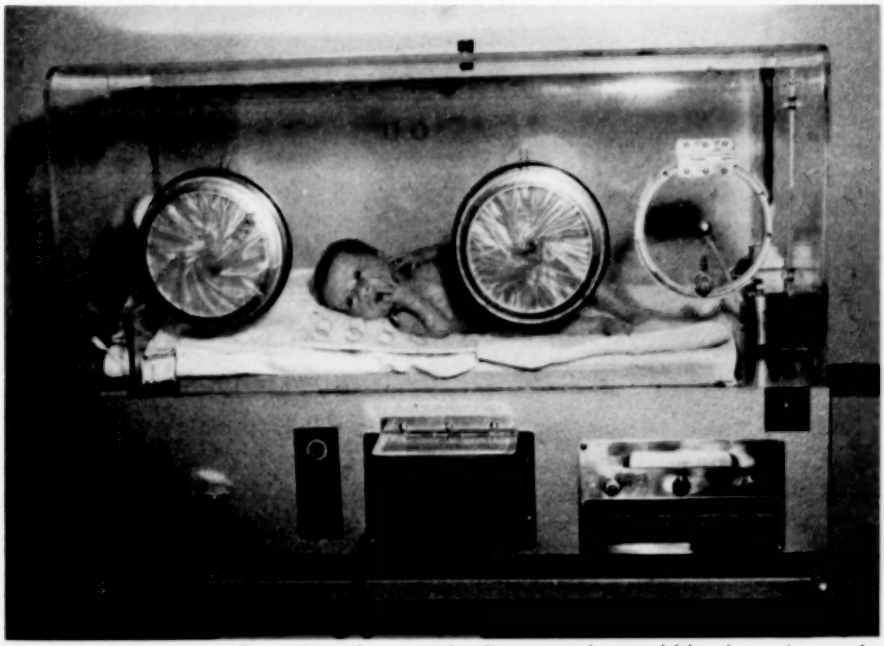

Fig. 6. Isolette. By automatic controls the atmosphere within the unit can be kept at a constant temperature and humidity. Oxygen can be introduced into the Plexiglas enclosure. Side portholes permit insertion of the nurse's or doctor's hands when caring for the infant. Openings in the lower edge allow for the different suctions and tubes.

gen for cyanosis, or oxygen and Levine tube with suction for alleviation of intestinal distention. Removal of excess tracheal mucus is accomplished by intermittent suction. The treatment of pneumonia requires oxygen and the giving of blood to increase the oxygen carrying capacity. All premature babies are given vitamin K (hykinone) 2.5 mg. subcutaneously daily. Before operation penicillin is given routinely to guard against infection.

Preoperative Drugs

Atropine (0.065 mg.) is administered subcutaneously approximately one hour prior to operation. No sedative is given preoperatively to any premature or newborn baby, because of the tendency to depress respiratory rate and volume.

Transportation to the Operating Room

The ideal method of transportation from the divisions to the operating room would be by the Isolette, but this is impossible due to the permanent electrical and oxygen attachments. The babies are moved in a warmed bassinette covered by a Plexiglas dome, and oxygen from a portable tank is supplied during transportation.

Prevention of Heat Loss

When, and only when, everything is in readiness in the operating room is the baby placed in a warm cotton blanket, his extremi-

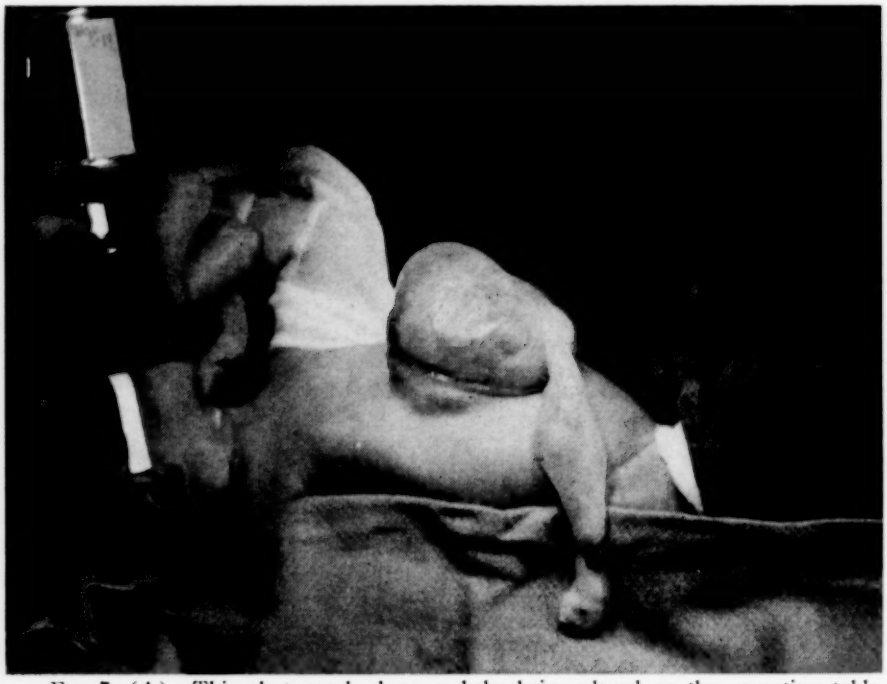

Fig. 7. (A). This photograph shows a baby being placed on the operating table. She weighed 4 pounds and had an omphalocele, treated by two-stage closure of the abdominal wall defect.

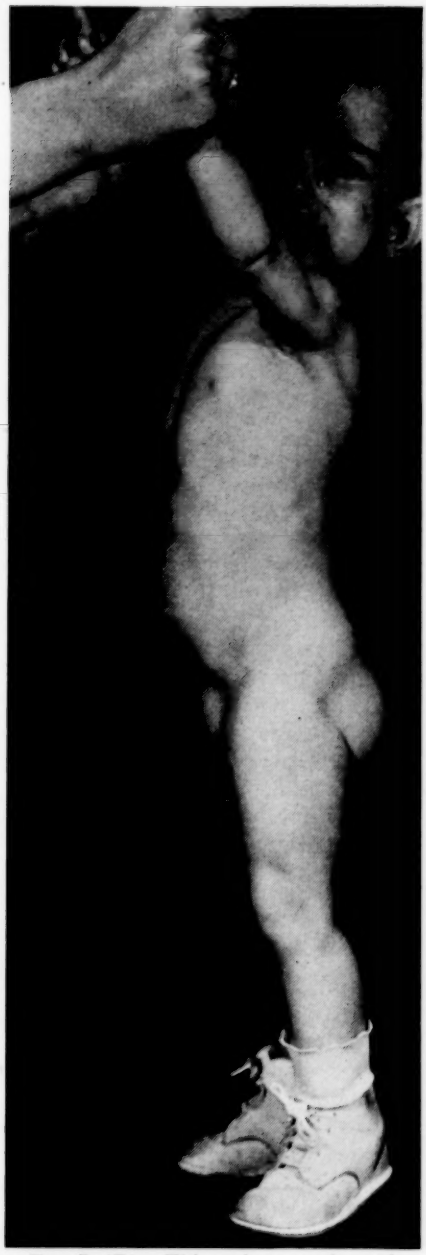

FIG. 7 (B). This photograph, taken after the second stage operation, shows satisfactory condition of the abdominal wall with a good muscular and fascial repair.

ties wrapped in sheet wadding to preserve as much body heat as possible, and moved to the operating table.

PREPARATION FOR INFUSION

In all premature babies, with the exception of those with hypertrophic pyloric stenosis, blood is required during the surgical procedure. Therefore a "cutdown" is performed on a median ankle vein or an antecubital arm vein. This "cutdown" is usually done under local anesthesia to eliminate the time element of the inhalation anesthesia.

FORMS OF ANESTHESIA

Local anesthesia. Perhaps the safest anesthetic is local procaine infiltration of the wound area. If this method is used on the normal full-term baby, with the exception of those presenting esophageal atresia with tracheo-esophageal fistula and hypertrophic pyloric stenosis, a brandy-glucose nipple is fed the baby during the procedure, but in the premature infant who has not developed the sucking motion this method is impossible to use. Local procaine anesthesia has serious limitations such as in the presence of abdominal distention, especially while opening and closing the peritoneum. If the chest is opened inadvertently or requires opening, certainly local anesthesia is not advocated. If the baby is anesthetized by the local method, he should be firmly restrained. While he may seem to be quite secure, despite his weakened condition he can wrig-

gle himself loose of almost any restraining ties. This makes it drastically difficult for the surgeon who is trying to work on a tiny baby who is moving.

Ethyl ether. We feel that ether is not the safest or the best anesthetic to use on the premature infant, and following are some of the reasons why we do not advise it: (1) low vital lung capacity; (2) irritating vapors of ether which sometimes lengthen the induction stage far too long for the safety of these babies; (3) high potency of ether. We have seen apnea occur several times during operations and we think it may have been due to this potency. The surgeon has to stop his work while the baby is being resuscitated, a disturbing situation for all concerned.

Cyclopropane. After many hazardous experiences over a number of years, with both local procaine and ether anesthesia, we are of the opinion that cyclopropane is the anesthetic of choice in these tiny babies. There are anesthetists who feel that the way to stay out of trouble with cyclopropane is not to use it, but experience in the past with other anesthetic agents has convinced us that we give a better anesthesia with comparatively few hazards when cyclopropane is the anesthetic used. Following is a list of reasons for the use of cyclopropane in the premature baby: (1) adaptability—due to the lightness of this gas it is far easier to control than is ether; (2) permits the use of high concentrations of oxygen; (3) nonirritating to the respiratory tract, which is so vital and important in these babies; (4) comparatively nontoxic to the vital organs; (5) rapidly eliminated. If at the completion of a 2 or 3 hour operation on these babies the face mask is removed or the baby is extubated and he gives a good lusty cry, the whole team is greatly elated and any spectators present are spellbound. Everyone realizes the great benefit the baby receives from the expansion of the lungs by this cry.

It is essential that the anesthetic be kept as smooth and even as possible. Cyclopropane will produce quiet, relaxing anesthesia if one does not allow the level to fluctuate by careless or nervous administration. The amount of this gas that these tiny babies tolerate with no untoward results or side effects sometimes is amazing. For the induction stage we usually proceed in the following manner: Using the to-and-fro system [see figures 8 (A), 8 (B)] with the barest amount of tubing, elbows, and connectors so as to eliminate all possible dead space, cyclopropane is allowed to run at approximately 350 cc. and the oxygen between 600 and 700 cc. per minute. This is kept at this level until the baby is well asleep. The maintenance stage for these babies has never failed to be alarming as it is rare that the cyclopropane cannot be carried lower than 200 cc. per minute, the oxygen usually 400-450 cc. per minute.

If intubation is necessary, ether is added to this mixture. This may not always be necessary, but we feel that the tube can be introduced more easily if the child has had a little ether. Cyclopropane is so quickly eliminated that the baby may cough and the intratracheal tube will be expelled.

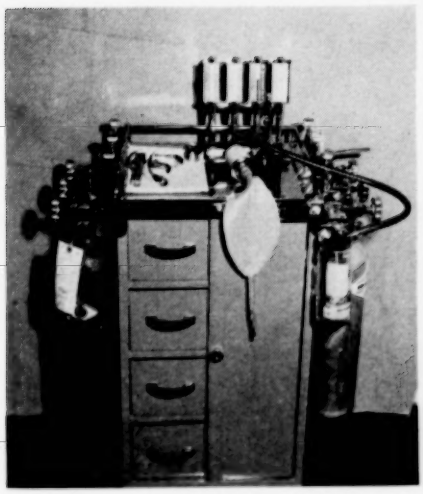

FIG. 8 (A). Heidbrink machine with the to-and-fro apparatus.

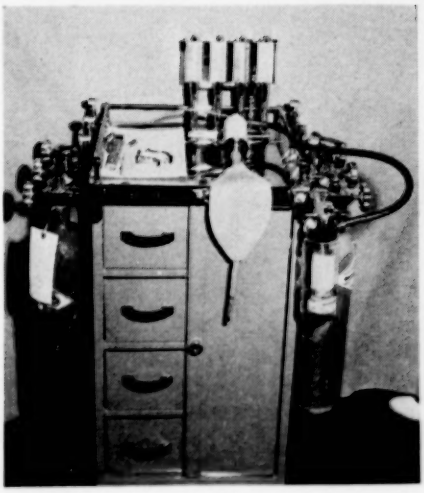

FIG. 9 (A). Heidbrink machine with the baby endotracheal apparatus attached.

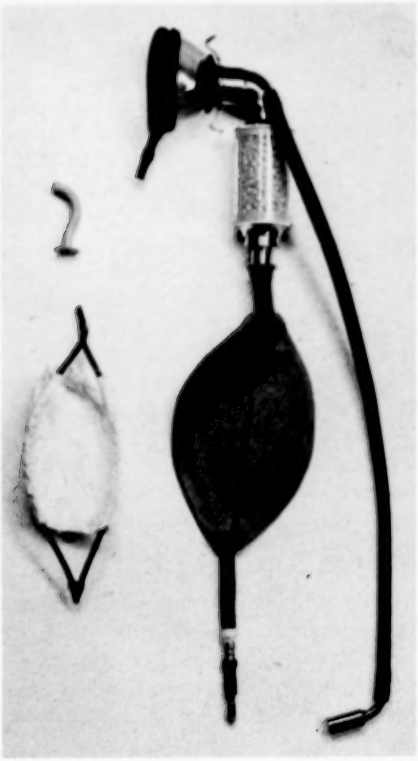

FIG. 8 (B). Enlarged view of to-and-fro apparatus.

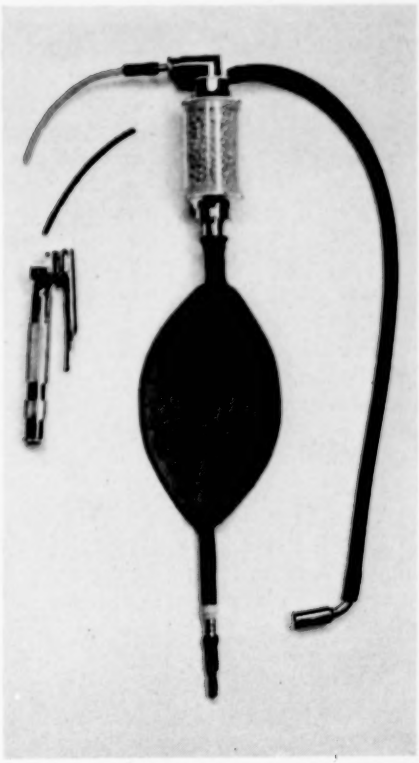

FIG. 9 (B). Enlarged view of endotracheal apparatus.

Cognizance of the Surgical Procedure

It has been reported that sometimes anesthetists set the dials, attach the intratracheal tube to the machine, and pay little attention to the progress of surgery or the patient. We feel that it is extremely important that the anesthetist pay strict attention to the progress of the operation. In this way the patient will receive not only better care but better anesthesia. The anesthetist by watching the progress of surgery can anticipate whether to deepen or lighten the plane as the situation demands. If deepening of anesthesia is required, we prefer to add ether rather than give a higher concentration of cyclopropane, as this will sometimes cause bradycardia, hypoxia and apnea with all its hazards. We often detect any variation in respirations or heart action by the simple method of strapping a stethoscope to the chest, and treat the condition before the complication becomes serious. The usual treatment is to empty the breathing bag, fill with 100 per cent oxygen and assist the respirations. Comparatively few inhalations of oxygen are required to correct both the heart and respiratory difficulties.

Laryngeal Intubation

At the Children's Medical Center we feel that intubation should never be a routine procedure in the premature baby group. The reasons are:

1. Danger of postoperative tracheal edema; this complication can be a serious one in the older group of babies, but can be fatal with the premature babies. For this group we naturally use the smallest intratracheal tube, the Magill rubber catheter #12. This catheter is soft and not likely to be traumatic, also it has a lumen which seems to be of adequate size. We have made tubes from polyethylene tubing which are minute in size but these are inadequate, due to the smallness of the lumen, making it difficult to inflate the lung and to eliminate carbon dioxide. Polyethylene tubes can be more traumatic than the Magill tubes, as they are stiff and hard and may tear the mucus membrane. We have seen one perforation of the trachea as a result of their use.

2. The premature infant's lungs are extremely friable and could very easily be overaerated by an inexperienced anesthetist.

We routinely intubate any premature baby where we think aspiration could occur, such as in the case of babies with abdominal distention. Occasionally we see babies presenting lung cysts or chest tumors. These certainly are candidates for tracheal intubation [see figures 9 (A), 9 (B)].

Although all of our operations for esophageal atresia are performed intrapleurally, intubation is not always required. This depends somewhat upon the condition of the baby, whether or not the child has had respiratory difficulty, and upon the surgeon who is to operate. Some surgeons like all of these infants to be intubated while some do not. Intubation (tracheal) is far safer for any of these tiny ones presenting any degree of pneumonia, or a lung partially filled with barium or excess secretions. With this group, it is far easier to keep the

tracheobronchial tree clear of secretions and the washing of carbon dioxide if intubation is performed.

A great number of these children have done amazingly well with the semiclosed system and an oropharyngeal airway. Also, we have been able to inflate the lung adequately with this method. However, there is always the one great fear "if the baby should suddenly stop breathing." If this occurs the baby is placed on his side with the right side presenting and is practically covered with drapes. To be sure, there is little room for the anesthetist to see or to work, but tracheal intubation is carried out as quickly as possible. The more rapid method of resuscitation is the mouth-to-tube insufflation, until such time as the baby can be put on the machine or take over himself.

Suctioning

For a suction catheter we use #18 or #19 polyethylene tubing attached to the regular suction catheter with adhesive. This allows adequate suction but with space in the intratracheal tube for air to pass back and forth. However, the baby may become dusky and occasionally anesthesia will quickly become light and spasm may develop. Therefore, this procedure should take the least possible time.

Extubation

After detaching the machine from the intratracheal tube, suction is employed through the tube. This is done several times making absolutely sure that the tracheobronchial tree is free from any mucus or secretions. The tube is then removed, but not with the suction attached as a sudden withdrawal of air and the tube may cause laryngeal spasm. We then listen to both sides of the chest to make certain that good breath sounds are heard.

Surgical Measures

We have successfully given anesthesia by the to-and-fro and intratracheal method to these small babies, without the serious postoperative complication of tracheal edema, but this certainly cannot be accomplished unless not only good but excellent surgery is being done. The surgeon must act swiftly, however, he should not be rough and the surgical technique must not be questionable. Any rough handling of viscera or tissue may be fatal for these babies. The shorter the period of time that these patients are subjected to anesthesia and the surgical procedure, the better are their chances for survival.

Postoperative Measures

It is important not to use too tight a dressing on the chest or abdomen as respiratory embarrassment may follow. Elastoplast applied loosely is very satisfactory because it has the ability to stretch. The babies who require gastrostomy, chest, or Levine catheters have to be closely watched or hands firmly restrained as frequently they become restless and despite the weakened condition can free themself of these important and lifesaving catheters.

Feedings

The babies are fed by gavage as the premature infant usually has a poor sucking action and if made to suck a nipple will become unduly tired. The tube is inserted and any fluid or air should be aspirated with a syringe rather than with suction. Suction can sometimes be too strong and cause damage to the mucosa. The formula is slowly instilled and the tube withdrawn.

Gastric Aspiration

Premature infants withstand long, constant gastric intubation poorly. The mucosa of these babies is extremely delicate and trauma such as edema and bleeding occurs very readily. It is our policy to use intermittent intestinal aspiration by passing a small catheter, #8 or #10 French (urethral), into the stomach every three or four hours and emptying the stomach. Also, if a Levine tube is allowed to remain for many days, it may cause obstructing edema to the glottis and pharyngeal mucosa which is so delicate and easily traumatized.

Fluid Therapy

These babies are particularly susceptible to overhydration. If this does occur the baby, being unable to secrete large amounts of urine, has a tendency to develop edema very rapidly. With different members of the surgical service caring for the baby, occasionally the orders are misinterpreted and the baby receives more parenteral fluid than was ordered and this (even a comparatively small amount) may be a lethal dose. We have seen babies die of overhydration but we do not remember seeing one die of dehydration. The surgical team have now developed a policy presetting the total amount of parenteral fluid for a 24 hour period and this is not exceeded. This method is carried out for the first four or five days postoperatively or the period when the baby is taking nothing by mouth.

Nursing Care

Complications and emergencies arise so swiftly and unexpectedly that one of the most important factors is *constant nursing care.* Delicate handling and watchful observation must be carried out until the baby is on the road to recovery, if the baby is to survive. The more common complications are of the respiratory type or the aspiration of stomach contents which can occur with great rapidity due to the weakness of the swallowing and respiratory muscles; therefore a suction apparatus must be constantly available. Also, it is of great benefit to keep an infant larynoscope with the proper size intratracheal tubes at the bedside in the event of an emergency, both for resucitative measures and for suctioning if aspiration occurs. Many times it is forgotten that a premature infant has the ability to feel pain and he is allowed to cry so long that the respiratory movements may be hindered, and also much needed rest prevented. It must be remembered that the baby may have become exhausted from crying and cannot let one know of his plight. Occasionally restlessness

occurs postoperatively which results in increased metabolic demands of the body. We have found that small doses of phenobarbital (2 to 6 mg.) given by mouth or subcutaneously every 6 to 8 hours is beneficial. Careful watching for oversedation must be maintained and the sedative reduced in dose or eliminated if necessary.

Summary

Of the 159 babies who had major surgical procedures at the Children's Medical Center, 88 survived and were discharged, a survival rate of 54 per cent. In 1951, the last year of the study, there were 19 premature babies who had anesthesia and a major surgical procedure with 15 survivals, a recovery rate of 79 per cent. Of the entire 159 infants, there were 10 who weighed less than three pounds at operation and seven of these survived.

A decade ago we would not have considered it feasible to do tracheal intubation on these tiny babies, but in recent years this has been carried out with success. Due to high steam postoperatively the babies have not required tracheotomy.

We used intratracheal anesthesia on 17 of the 159 premature babies. Only one of these had postoperative atelectasis and pneumonia. All of these with intubation have been done in the last several years. Tracheal intubation where indicated is a distinct advancement in the total care of premature babies.

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Recent Cardiovascular Researches in Relation to Anesthesia

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In order to present the maximum number of recent research problems in a useful and concise manner this article has been limited to three projects:

1. The plasma volume expanders in the treatment of shock;
2. Methods of transfusing the patient when veins are not available or the intravenous route is ineffective;
3. Hypothermia in cardiac surgery.

The Plasma Volume Expanders

The search for blood substitutes has been under way for many years. Denis in 1667 reported transfusions of several patients with lamb's blood. There must have been some difficulties because this technique was prohibited by the French government soon thereafter.[1] Latta in 1831[2] was the first to use normal saline solution in the treatment of shocked cases. However, his patients frequently returned to the shocked state as the normal saline solution was distributed in the body. During World War I, when the transfusion of whole blood was a major procedure and many factors causing transfusion reactions were as yet unknown, Hogan[3] advocated the use of gelatin as a plasma volume expander. Gelatin was successful in elevating the blood pressure in shocked cases but large quantities were needed because the solutions were excreted rapidly through the kidneys. A solution of acacia was tried.[4] This substance also proved highly effective in relieving shocked states but reports of reactions and deaths after its use began to appear in the literature. In addition, autopsy reports revealed evidences of long-term storage in the internal organs, mainly the liver and spleen.

The imminence of World War II started another wave of experimentation in Europe and the United States. It was obvious to scientists in all countries that there would not be enough blood or plasma to care for the casualties in widespread battles or bombings. The German investiga-

Read before the Twentieth Annual Meeting of the American Association of Nurse Anesthetists, San Francisco, August 31, 1953.

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tors developed polyvinylpyrrolidone (PVP), a derivative of acettylene.[5] More than a half million bottles of PVP were given to German soldiers and civilians with excellent clinical results. The Swedish scientists discovered a product which they called "Dextran." Dextrans had been known for almost a century as contaminants in sugar refining. Ingleman[6] noted that dextrans would expand plasma volume. Thorsen[7] used it clinically in many shocked patients with excellent results.

Meanwhile, other products were being tested here and abroad. Isinglass, a fish gelatin; pectin, a common substance used by cooks; milk casein; cadaver blood; methyl cellulose; and animal blood proteins were tested but found wanting in some respect.[1]

The onset of World War II found the United States Government with small stockpiles of blood or blood substitutes. Immediate and extensive researches were initiated to discover techniques of manufacturing dried plasma, the most logical product from a viewpoint of transportation and use in varied climates. There is no question about the thousands of lives it saved.

Not until after World War II was there accurate correlation between the use of plasma and the occurrence of hepatitis. Hepatitis had been noted in many wars of the past. Only after enough cases occurred in association with the use of plasma was plasma implicated as a means of spreading this disease. With the onset of the Korean conflict and the danger of an atomic attack on this country, it became imperative to have a virus-free plasma or some other blood substitute.

Further researches with gelatin were initiated. Gelatin solutions had been given to several thousand troops in the Burma-India theatre in World War II for the treatment of shock.[8] It was effective but had several drawbacks. In addition to the already mentioned need for large quantities of gelatin solution, it was necessary to warm the gelatin before administration because the product was jellylike at room temperature.

Modified gelatins which remained liquid at near freezing temperatures and remained in the blood stream for longer periods of time were and are being synthesized in laboratories. One such product, Oxypolygelatin (OPG), has been highly effective in the treatment of shock.[9] Other modified gelatins have been tested in the United States and on the battlefield in Korea by Dripps, one of our own anesthesiologists. The Council of Pharmacy and Chemistry of the American Medical Association has accepted several gelatins for clinical use and some of these are being stockpiled by the United States Government for emergencies.

Polyvinylpyrrolidone (PVP) was and is being studied further.

5. Polyvinylpyrrolidone (PVP). New York, General Aniline & Film Corp., March, 1951.

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It would be an excellent product, being easily manufactured from readily available acetylene. One drawback has been the failure to account for all the injected material.[10] Approximately 75% can be found in the excreta but scientists are trying to trace the other 25%. Tests with radioactive samples are being conducted to determine whether the 25% is being stored in the body just as was acacia and/or whether this material is causing pathologic function of any of the internal organs.

To date, dextran has been found to be the most effective plasma volume expander from an over-all clinical viewpoint. A letter, dated 4 June 1953, Subject: "Clinical Use of Dextran," Hq., USAF, summarizes the thinking in one branch of the Armed Services on the use of dextran:

"There is sufficient clinical evidence to indicate that Dextran, a polymer of glucose, is a satisfactory plasma volume expander, and that, as a therapeutic agent in the preliminary or emergency phase of the treatment of shock, the results are essentially the same as may be expected from plasma. . . . Among the advantages of Dextran over plasma are the simplicity of administration, lower cost, and the fact that it does not cause serum hepatitis. . . . Commanders of medical facilities are enjoined to requisition supplies of Dextran and to use it as a substitute for plasma."

However, it is not without its dangers. It was my privilege to be associated with the Surgical Research Unit at Brooke Army Hospital, which tested dextran for the Armed Services. Whereas the Swedish scientists reported reaction rates of only .4%,[7] volunteers at Brooke Army Hospital who were given this material intravenously gave higher reaction rates.[11] There was no difficulty in obtaining volunteers. The soldiers returning from Korea were only too willing to assist those still fighting. The following table illustrates the reaction rates with Swedish dextran:

	Number Reactions	Number Patients	Per cent Reactions
Total Swedish	37	109	33.9

On the other hand, a product manufactured in the United States under Swedish patent but using a different strain of bacterium to synthesize the dextran caused only the following reaction rates:

	Number Reactions	Number Patients	Per cent Reactions
Total American	8	97	8.24

Clinical testing of the material has been continued at Lackland Air Force Base. Two hundred forty-one basic airmen were tested in groups and the findings with the army volunteers at Brooke Army Hospital verified. It was also determined that service immunizations had no effect on reaction rates and that reinfusion of patients who had had infusions of dextran previously did not result in increased reaction rates.

The latest report to Hq., USAF, dated 9 July 1953, states:

"Reaction rates in 113 anesthetized patients given 132 bottles of

10. Van Slyke, D. D.: Report of periston analysis to the National Research Council, March 19, 1951.

7. Thorsen, G: *Loc. cit.*

11. Tarrow, A. B.: Dextran—a plasma substitute. Review of literature, clinical and laboratory observations. Thesis. Baylor University Graduate School, 1951.

dextran in the previous six months . . . 2.65%."

The following cases illustrate typical dextran reactions:

E.B. — This patient was given the infusion two days postoperatively. He gave a history of allergies to many materials. Within minutes, he complained of running nose, wheezing and became very red. Swelling around the eyes was severe. It required helium and oxygen by inhalation plus intravenous benadryl to relieve his symptoms.

L.T. — This patient reacted while under pentothal-nitrous oxide anesthesia for a breast biopsy. Just before she awoke from the anesthesia, urticaria and difficulty in breathing were noted. The eyes swelled soon after. Intravenous benadryl relieved her symptoms but the swelling of the eyes persisted for a day. She volunteered to take another infusion when awake. Symptoms appeared immediately. The residuals of this latter bottle which caused her symptoms was given to another patient under spinal anesthesia and caused no reaction.

Intramedullary and Intra-arterial Transfusions

Originally, blood was transfused by anastomosing arteries.[1] It was one of the drawbacks of the early transfusion techniques. Arteries were sacrificed and a relatively complicated surgical procedure had to be accomplished.

Our present intravenous methods are excellent. There are times, however, when the arms, legs, and even neck or scalp are unavailable, such as occurs in the severely burned patient. He needs large quantities of blood in the early phases of shock and frequent transfusions thereafter.

Researches into the technique of introducing blood into the bone marrow have proved that in such circumstances the marrow of the sternum, crest of the ilium, or the tibia may be used.[12] The marrow becomes a blood vessel surrounded by bone. Many other substances besides blood have been introduced into the general circulation, including intravenous anesthetics, x-ray opaque dyes, sulfa drugs, antibiotics, digitalis, heparin, insulin, antitoxins, analeptic agents and many others.

No one advocates the use of the bone marrow route routinely. Rather is it useful when veins are not available, as in burns; or too small, as in newborn infants; or collapsed, as in shock. The bone marrow needles may be left in place for several days if sterile precautions are taken.[13]

There are several drawbacks to intramedullary transfusions:

1. When the patient is awake, infusion of thick fluids (such as blood) under pressure causes pain. In the anesthetized state this is not a problem.
2. A surgical procedure is involved, requiring careful surgical cleansing. There is danger of osteomyelitis if sterility is not observed.
3. Introduction of the needle requires technical knowledge.

We have found the bone marrow technique very effective in the newborn or young infant (i.e., for harelip procedures). The tibial bone marrow needle may be introduced in a matter of 3 to 5 minutes with a patient in any position if and when an intravenous cut down becomes ineffective. Blood

1. Kilduff, R. A., and DeBakey, M.: *Loc. cit.*

12. Turkel, H.: Trephine Techniques of Bone Marrow Infusions and Tissue Biopsies, ed. 6, Detroit, Gale Printing Co., 1952.

13. Tarrow, A. B.; Turkel, H., and Thompson, M. S.: Infusions via the bone marrow and biopsy of the bone and the bone marrow. Anesthesiology **13**:501-509 (Sept.) 1952.

will pass readily through the large bore intramedullary needle. Analeptic agents have almost as rapid action as after intravenous injection.

There has been much recent work in intra-arterial transfusions. In cases of collapse on the operating table or in the emergency room, many instances of resuscitation by this method have been reported.[14,15] The radial artery is most frequently used. A small incision at the point where the pulse is felt quickly reveals the artery. A cannula is pointed toward the heart and tied in securely. Blood pumped under pressure quickly fills the brachial and subclavian arteries and the aorta. The heart has something to pump against and normal hemodynamics are established, breaking the vicious cycle of shock. The femoral artery is another site which may be approached by either blind techniques or by cutting down.

There are several disadvantages and difficulties with intra-arterial transfusion:[16]

1. It requires incisions and surgical treatment in most instances. In an emergency, however, surgical scrub and incision may be accomplished while the transfusion set is being readied.
2. Thrombosis of arteries and gangrene of the extremities have been reported following intra-arterial transfusion.[17]

14. Hale, D.E.: Arterial infusion. Ohio State M.J. **46**:317-318 (April) 1950.
15. Seeley, S. F., and Nelson, R. M.: Intra-arterial transfusion: Collective review. Surg., Gynec. & Obst. **94**:209-214 (March) 1952.
16. Tarrow, A. B.: Intra-arterial transfusion. Address to the Assembled Air Force Surgeons, Lackland Air Force Base, May 4, 1953.
17. Blakemore, W. S.; Dumke, P. R., and Rhoads, J. E.: Gangrene following intra-arterial transfusion. J.A.M.A. **151**:988-989 (March 21) 1953.

Recent work by Maloney and associates[18] has also tended to question the greater effectiveness of intra-arterial transfusions as compared with intravenous transfusions when given under pressure.

These reports have resulted in reserving intra-arterial transfusion techniques for those cases wherein the intravenous route has been found wanting after a fair trial. This may mean an immediate decision in a severe collapse on the operating table or in the emergency room.

Hypothermia in Cardiac Surgery

An interesting phase of the research in cardiac surgery is the development of a "heart-lung bypass" machine. Another is the technique of reducing the temperature to such levels that the patient is in a state comparable to animal hibernation. During this period major blood vessels may be clamped off and the heart opened for short periods without blood loss. The surgeon may operate in a bloodless field.

From Hahnemann Hospital in Philadelphia[19] a report is available on one technique of hypothermia which has been used for cardiac surgery with 16 patients. The procedure is as follows:

The patient is placed on a cooling blanket. It is made of a double layer of rubber sheeting inside of which is placed a continuous coil

18. Maloney, J. V.; Smythe, C. M.; Gilmore, M. S., and Handford, S. W.: Intra-arterial and intravenous transfusion: a controlled study of their effectiveness in the treatment of experimental hemorrhagic shock. Naval Medical Field Research Laboratory **111**:299 (Dec.) 1952.
19. Downing, D.F.; Cookson, B. A.; Keown, K., and Bailey, C. P.: Hypothermia in cardiac surgery. Brochure. Hahnemann Hospital, 1953.

of tubing, connected with a pump which circulates ice water.

The patient is anesthetized and intubation performed. A thermocouple is placed in the rectum to record body temperature and an electrocardiograph is connected to appropriate leads.

The patient is cooled until the desired temperature is attained (68-88° F.).

Several factors must be taken into consideration. Intubation is necessary to control shivering which delays the cooling process and also to control the respirations which cease when the temperature is reduced below 82.4° F. This temperature seems to be an endpoint because respirations resume spontaneously when the patients are warmed from lower temperatures. The ECG shows changes which suggest prolongation of the conduction time of the cardiac nervous tissue. Normal rhythm usually persists unless there has been an abnormal rhythm beforehand. The blood pressure falls and may reach low levels. At 80° F., the pulse rate averages one half that of normal.

Rewarming is done by circulating warm water through the coils. Patients are rewarmed rapidly to 80° F. from any lower temperatures. Above 80° F., further warming is accomplished in 4 to 6 hours.

Operations on 16 patients are reported, with ages varying from 10 days to 33 years and with hypothermia ranging from 68-88° F. These patients had cardiac anomalies including atrial septal defect, ventricular septal defect, tetralogy of Fallot, transposition of the great vessels, the Taussig-Bing syndrome with pulmonary stenosis, nonfunctioning right ventricle, mitral insufficiency and aortic insufficiency.

It was stated that 11 patients died in the operating room or in the immediate postoperative period. The main question which this research had to answer was whether hypothermia aided the patients and enhanced their chances of survival.

At first glance, these figures might seem discouraging. However, closer examination of the physical status of the patients at the time of surgery reveals them to be in that group which could not have survived without operation. It was thought that several would not have survived surgery of any kind with conventional anesthesia.

Conclusions from this report are as follows:

1. "Hypothermia is indicated as part of the anesthetic regime in all severely cyanosed and disabled infants who are to undergo cardiac surgery of any nature."

2. "If it is the surgeon's intention to open a cardiac chamber or to interrupt the circulation during the performance of an operation, hypothermia is certainly indicated. An effective and reliable heart-lung apparatus might be a better answer to the problem involved here, but until it is perfected, hypothermia best fills the need."

3. "The chief contraindication to the use of hypothermia is the presence of a noncyanotic lesion for which the surgical technique does not require interruption of the circulation . . . mitral or aortic insufficiency, mitral commissurorrhaphy are examples."

4. "Advanced age is also a contraindication. Ideal in infants and young children, hypothermia should be used cautiously in older children and should be avoided in those over the age of 10 years."

Summary

1. The history of the search for blood substitutes has been outlined. The research into the properties of the plasma volume expanders now in active use in the treatment of shocked patients was considered.

2. The use of the intramedullary and intra-arterial routes for transfusions, when intravenous therapy appears impractical or ineffective, has been discussed.

3. The technique of hypothermia for cardiac surgery was outlined from a brochure, Hahnemann Hospital, Philadelphia, Pa.

Anesthesia for the Crippled Child

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As in the field of anesthesia for the adult patient, the field of anesthesia for children has widened greatly in recent years due to the progress made in pediatric surgery. Or, conversely, it may be that the field of pediatric surgery has widened due to the advances made in pediatric anesthesia. In any case, operations previously performed at great risk now are being accomplished with a greater margin of safety to the patient and with a greater degree of confidence on the part of the surgeon. This is particularly true of working with the crippled child who frequently is a post-poliomyelitis patient or is afflicted with cerebral palsy. The margin of safety therefore is considerably lessened, but with the application of sound fundamentals and close attention to small detail the newer technics are of great value.

This is a report of the anesthesia procedures employed in a 100 bed hospital for crippled children. The program through which the hospital operates is the State Crippled Children's Service which refers a wide variety of surgical patients ranging in ages from one year through adolescence. In addition are older patients from the Rehabilitation Center and the Spastic Aid. Many of the patients require multiple operations, frequently remaining in the hospital over long periods, consequently they and the hospital staff become so well acquainted that the work takes on a very personal nature. It is obvious that a program in a specialized hospital is not comparable with a program in a general hospital. In fact, much of the work accepted as routine in this hospital would not be feasible in a general or possibly in a larger specialized hospital. This hospital has a relatively small closed staff, an advantage in promoting teamwork. The teamwork is set in motion when the patient is admitted to the hospital and by the time he is scheduled for surgery he is completely oriented and feels that he is among friends.

In addition to the simple orthopedic procedures commonly performed on crippled children, such as heel cord lengthening or closed reduction of congenital dislocation of hip, our schedule includes the following surgical procedures: arthroplasty of the hip, acetabular shelving, cleft palate repair, craniotomy, epiphysial stapling, epiphysial stimulation, fasciotomy of the thigh, iliomuscle transfer, Jones' suspension of the foot, laminectomy, Nicola's operation

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of the shoulder, open reduction of congenital dislocation of the hip, opponens transfer, osteotomy of the femur, pedicle graft, popliteal partial neurectomy, radical dissection of glands of the neck, removal of spinal cord tumor, spinal fusion for scoliosis, tibial osteotomy, section of the sternocleidomastoid muscle, triple arthrodesis, and many others.

As a candidate for anesthesia the post-poliomyelitis or cerebral palsy patient is unpredictable. It is essential therefore that a most careful preanesthetic preparation be obtained and that extreme care be exercised in having close at hand the necessary equipment with which to meet any emergency (see figure 1). An accurate evaluation of physical change while under anesthesia is imperative. Great stress is laid upon the psychological approach to the induction to insure a smooth anesthesia.

In view of the fact that successive operations may be necessary, care is taken to avoid any unpleasant features in the initial anesthesia. This hospital is indeed fortunate in having the patients available for a sufficient time before surgery for them to become friends with the anesthetist. They ask innumerable questions about going to sleep and listen attentively to what is said. Frequently the children are taken on a tour of surgery and shown the gas machines, anesthetic tables, arm boards, syringe holders, how the operating tables may be placed in different positions and how the orthopedic table operates when casts are applied.

Surgery is elective, being scheduled 48 hours in advance with de-

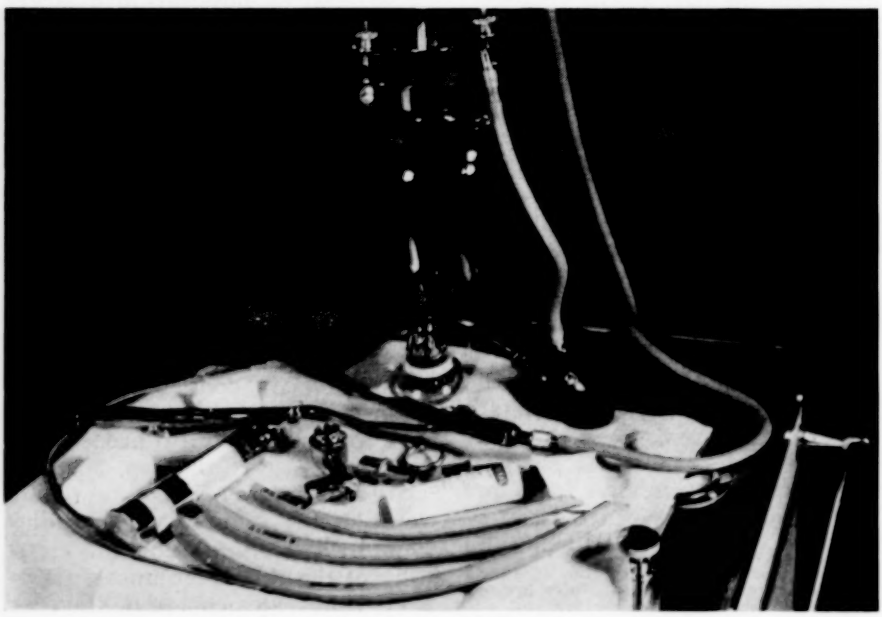

FIG. 1. Accessory equipment kept at hand to meet any emergency during operation.

tailed preparation. On the day preceding surgery a final complete physical examination is obtained, laboratory findings rechecked, transfusions given when indicated and the type of anesthesia best suited for the individual decided upon. A cleansing bath is followed in the early afternoon with surgical preparation of the field of operation. A light supper is given at 5 o'clock, followed with a dose of phenobarbital at bedtime. Liquids are withheld after midnight. If rectal anesthesia is to be administered a low cleansing enema is given. Premedication is administered 45 minutes before surgery. Preanesthetic medication is considered essential before anesthetizing children. In addition to allaying apprehension and reducing hypersecretion, it also slows the respiratory rate. The weight and age are used to determine the dosage, according to the following table:

children. It is believed at this hospital that there still is an important place in anesthesia for ether and that postether nausea and vomiting may largely be prevented by adequate preanesthetic medication, a careful plane of anesthesia, adequate oxygenation and patent airway. Adequate oxygenation also aids in the prevention of accumulation of carbon dioxide.

In children under 5 years of age rectal pentothal sodium as a preanesthetic hypnotic is administered in the bed 15 minutes before going to surgery. Drop ether-nasal oxygen is usually the anesthetic of choice unless an intratracheal tube is indicated; then a Stephen-Slater rebreathing valve is used with a mixture of nitrous oxide-ether-oxygen, with assistance being given at intervals by intermittent manual compression of the bag.

For children from 5 to 10 years of age the to-and fro absorption

TABLE OF DOSAGE FOR PREANESTHETIC MEDICATION

AGE	WEIGHT	MORPHINE SULPHATE	SCOPOLAMINE	ATROPINE SULPHATE	NEMBUTAL
1- 2 Yrs.	24-27 lbs.	1/72 gr.	1/500 gr.	1/450 gr.	½ gr.
2- 3 "	27-30 "	1/64 "	1/400 "	1/450 "	½ "
3- 5 "	30-40 "	1/48 "	1/300 "	1/350 "	½ "
5- 8 "	40-50 "	1/32 "	1/300 "	1/300 "	1 "
8-10 "	55-60 "	1/24 "	1/250 "	1/200 "	1 "
10-12 "	65-80 "	1/16 "	1/200 "	1/200 "	1 "
12-14 "	80-90 "	1/12 "	1/200 "	1/150 "	1½ "
Over 14	90-	1/8-1/6 gr.	1/150 "	1/150 "	1½ "

NOTE: Staff pediatricians of this hospital disapprove the use of morphine sulphate in children under 12 years of age.

In recent years in the presence of newer agents there has developed in some areas a tendency to discredit the use of ether, particularly in the open drop method for

technic with exhaling valve is preferred. To remove the carbon dioxide which may accumulate under the mask, the exhaling valve is opened occasionally and the bag

flushed with additional oxygen, care being taken that the plane of anesthesia is not disturbed. Anesthetic administration is not commenced without having two canisters in readiness, so that a necessary change may be made without upsetting the anesthesia or disturbing the surgeon. A canister holder (fig. 2), made in the brace shop has proved to be of great assistance in using this technic. It prevents leakage around the mask and in case of an emergency enables the anesthetist to have the use of both hands.

Children over 10 years of age, unless they are very small, are inducted with a 2½% solution of pentothal sodium supplemented with 50% mixture of nitrous oxide-oxygen or cyclopropane. In hip nailings, arthroplasty, osteotomy of femur, fasciotomy or other operations in which there is considerable trauma or blood loss, nitrous oxide-ether anesthesia has proved to be a more desirable choice. There is less drop in blood pressure, the patient reacts more quickly and the immediate postoperative condition in general is more satisfactory. In operations where it is possible to use the pneumatic tourniquet and where the electric coagulating unit is not employed, cyclopropane is frequently administered. A considerable amount of orthopedic surgery is performed with x-ray control; in such instances pentothal sodium is of great value because of its nonexplosive quality and for the opportunity it affords to carry the patient under light anesthesia without its attending disturbances, while the pictures are being made and developed.

FIG. 2. Improvised canister holder prevents leakage around the mask and allows the anesthetist to use both hands when necessary.

Intravenous Anesthesia

While the surgical preparation of the patient is in progress the arm is prepared for venipuncture. A Rudder syringe holder with a 3-way stopcock and tubing constitute the equipment. The vein is injected and the syringe tubing with observation tube attached is connected to the needle, a 5% solution of dextrose in distilled water is then connected to the side opening of the stopcock. As the dextrose solution drips it carries to the patient the pentothal solution contained in the syringe tubing, thus producing a state of analgesia. As the sterile draping is completed the pentothal sodium is slowly injected until the patient loses consciousness. A face mask then is applied and a 50% mixture of nitrous oxide and oxygen administered with the pentothal sodium being continued intermittently as indicated. If the operation necessitates excessive blood loss or trauma, the pentothal sodium is discontinued and the ether valve opened to produce a deeper plane of anesthesia. By the time the cast has been applied the patient is reacting and is required to remain in the recovery room for only a short while. These patients seldom experience nausea or vomiting, usually enjoying an uneventful recovery. An oral airway is inserted in all patients before leaving the table, if one may be tolerated, and is allowed to remain in place until removed by the patient.

Rectal Pentothal Sodium

This proves to be a most satisfactory preanesthetic hypnotic, particularly in the cerebral palsy patient. A 10% solution, with dosage computed on body weight, is given. If ether is to be given, the patient is inducted slowly because of the light dosage, otherwise the induction will be associated with struggling and hypersecretion. We also find it necessary to transfer the patient to the operating table very quietly and gently. The surgical preparation is not commenced until the patient is fully anesthetized.

Positioning the Patient

In orthopedic surgery the position of the patient is an important part of the operation. It is the responsibility of the anesthetist to see that the position required by the surgeon does not interfere with securing a free airway and an adequate respiratory exchange. Because of the danger associated with change of position under anesthesia we endeavor to place the patient in the desired position before induction. Sandbags of varied shape and size are used to maintain the position. In operations requiring the prone position intratracheal technic is employed, but the majority of operations may be performed in the horizontal position with the necessary adjustment and modification. Operations requiring the application of a spica cast are performed on the orthopedic table. A long aluminum arm board is placed beneath the shoulders and arms extended (see figure 3). A special anesthetist's screen for this table stands on the floor extending over the table and is easily movable. For small patients requiring spica casts, such as open reduction of

congenital dislocation of the hip or Ober-Yount fasciotomy, the operation is performed on the regular operating table. When the operation is completed, the patient is gently lifted with sufficient help, a small Albee table is placed on top of the operating table and the patient is then lowered to the small table. The anesthetic is continued without interruption while the cast is applied.

Spinal Fusion for Idiopathic Scoliosis

Patients with idiopathic scoliosis cause a great deal of concern to both the surgeon and the anesthetist. Upon admission to the hospital the patient undergoes a thorough physical examination after which he is placed in a Risser jacket, which consists of a plaster body cast incorporating one thigh, and provided with anterior hinges and a turnbuckle on the side of the chest cavity. Six weeks or more, according to the severity of the deformity, are required before the desired correction is effected. The stabilization then is secured by means of spinal fusion performed through a window in the posterior aspect of the cast (see figure 4).

In preparation for the anesthetic the patient is premedicated and the nose and throat sprayed with pontocaine 1% solution while the patient is in his room. He then is taken to the anesthesia room where he is inducted while on the stretcher, with intravenous pentothal sodium 2½% solution. As consciousness is lost, 2 to 4 cc. of tubocurarine is injected into the

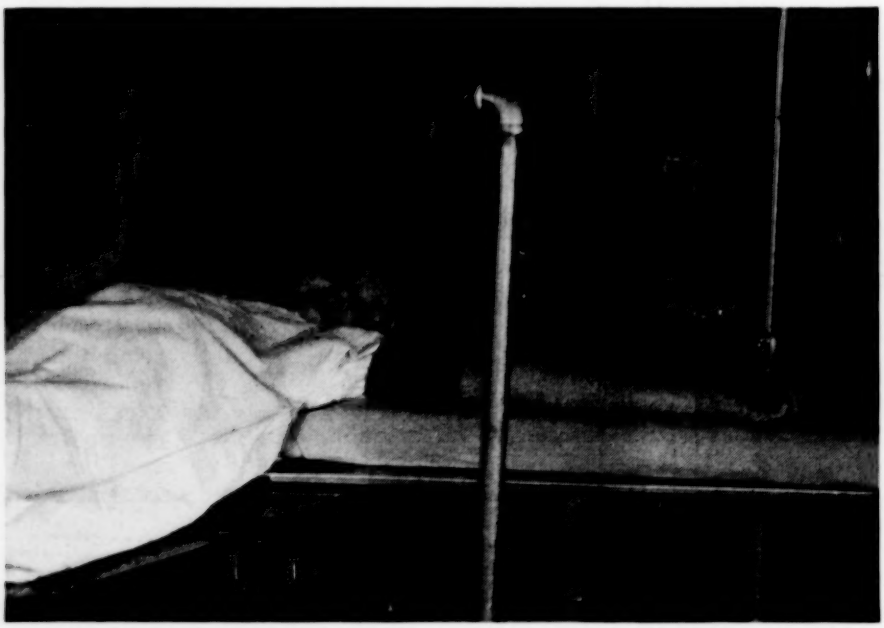

Fig. 3. Long aluminum arm board and anesthetist's screen for use with orthopedic table.

vein and oxygen administered with mask. The nose and throat are again sprayed with pontocaine and intubation is performed; the approach is determined by the height and shape of the jacket collar. If the collar fits closely around the chin, preventing a satisfactory manipulation of the mandible, blind intubation is indicated. When intubation is completed the face mask is again applied and when an adequate respiratory exchange is obtained, the patient is placed in the prone position on the operating table with the head on headrest. (see figure 5).

Sufficient padding is correctly placed to prevent facial pressure. Working through the cast eliminates the necessity of placing protector pads beneath the shoulders and pubic bone. Arm boards are so placed that the arm position does not interfere with the surgical procedure and is without pressure on the brachial nerves. The special anesthetist's screen is used, permitting the surgical team to work to better advantage and affording the anesthetist an unobstructed field. The anesthetic is continued with nitrous oxide-ether-oxygen. If the electric coagulating unit is not used, cyclopropane is administered without ether. A slow blood transfusion is commenced at the beginning of the operation and increased in rate according to the pulse rate and the blood pressure reading. An estimated amount of blood loss is replaced.

At the conclusion of surgery extubation and suction are performed before removing the patient from the table. Oxygen is then administered under pressure, following which the patient is placed horizontally in bed and the bed adjusted to the Tredelenberg

FIG. 4. Intubated patient in prone position with head on rest.

position to obviate a transitory drop in blood pressure following the change in position. The patient then is placed in the recovery room for an hour or more under observation, even though fully recovered from the anesthesia. Nasal oxygen is administered for 24 hours. A saw is kept in readiness to remove the jacket without delay in the event of respiratory arrest either during the operation or following surgery.

Cleft Palate and Lip

The technic depends to a great extent upon the surgeon. If intubation is indicated or the surgeon desires intubation, it is performed, but our usual method, which has proved to be most satisfactory, is quite simple. The patient is premedicated with atropine sulphate and rectal pentothal sodium and inducted with drop ether. When the patient is fully anesthetized and the sterile preparation is completed, a surgical assistant inserts a sterile insufflation catheter through a nostril and sufficiently high in the throat to avoid the surgical field. It is then fastened under a sterile drape and attached to a Y connection to which is also attached the ether and oxygen tubings. The surgeon sits at the head of the table with the patient in a slight Trendelenberg position. The tongue is then brought forward with a suture in the median line and the suture fastened to the drape. A throat pack with string attached is inserted by an assistant who handles the suction and changes the pack when necessary, thus preventing aspiration of blood. The anesthetist sits at the right of the patient. A malleable screen is used which affords the anesthetist a clear view of the patient and enables her to control

Fig. 5. Showing site of operation through opening in Risser jacket.

the anesthetic and the airway beneath the sterile drape. These patients usually are reacting when removed from the table and make an uneventful recovery.

Removal of Spinal Cord Tumor

Patients in this category have ranged in age from 10 to 14 years. These patients are given a basal anesthetic of avertin or rectal pentothal sodium. The nose and throat are sprayed with 1% pontocaine solution and if not sufficiently relaxed for intubation, 2 to 3 cc. of tubocurarine is given intravenously. When intubation is completed, the patient is placed in the prone position with head on a rest and the anesthetic continued with nitrous oxide-oxygen-ether. Circulatory failure due to blood loss or trauma is guarded against by maintaining a proper depth of anesthesia and by blood replacement.

Operating Room Hazards

The practice of anesthesia is concerned with more than the actual administration of an anesthetic agent. The use of a great deal of electrified equipment is required in orthopedic surgery. It is the responsibility of the anesthetist to see that the personnel is properly instructed and that necessary precaution is exercised while an appliance is in use. The greatest hazard in even the most modernly constructed and equipped operating room is the electrostatic spark in the presence of combustible anesthetic mixtures. This building has been in operation for two years and while the fire marshal has given an "A" rating on each of his periodic inspections, all personnel are, nevertheless, hazard conscious.

The terrazzo floors are grounded, the view boxes, lights, wall receptacles, clocks, etc., are explosion-proof. The furniture is equipped with either metal drag chains or conductive rubber casters. Drag chains are preferred as the casters quickly collect a coating of foreign substance from the floor, which unless washed off frequently, defeats the purpose of the conductivity of the rubber. In addition three wet towels are included in the setup for each anesthesia, one being placed on the base of the gas machine and touching the floor, another in similar position on the operating table and the third on the machine for the anesthetist's hands. In radical dissection of the neck, condylectomy, or in other operations performed in the vicinity of the mask where a surgical cutting unit or electrical drill may be used, a wet towel protected by a piece of conductive rubber is placed over the mask. The staff and personnel wear conductive rubber-soled shoes. Nylon or rayon uniforms and undergarments are not permitted to be worn in surgery. The success of this policy, which is strictly adhered to, is the result of friendly teamwork existing between the members of the departments of anesthesia and surgery and the surgical staff.

Recovery Room Nursing Service

This article would not be complete without special reference to the benefit derived by the department of anesthesia from the recovery room nursing service. The

recovery room is located within the surgical suite, making it quickly accessible to medical assistance. It is under the supervision of the department of anesthesia and staffed with graduate nurses who have been especially trained in the postanesthetic care of the patient. It is a point of great satisfaction to the anesthetist to know that while he or she is engaged in the administration of successive anesthetics, those patients previously administered to are being cared for by a competent staff. Emphasis should also be placed on the fact that the equipment necessary to meet an emergency, should one arise, is immediately available. When a patient is returned to the ward he is fully awake and quiet, thus bringing about a desirable psychological effect upon the other patients.

In conclusion may I state that the practice of "Anesthesia for the Crippled Child" is one of great pleasure and that a successfully administered anesthetic is a source of innermost satisfaction, especially if one has "Walked through the Valley of the Shadow" as we sometimes do. However, it is my belief that a successfully administered anesthetic is not just the work of one person, but the result of coordinated effort on the part of all who have had a part in serving the patient in preparation for the anesthetic and in the immediate postanesthetic care.

SUMMARY

The margin of safety existing between satisfactory anesthesia and cardiac and respiratory arrest is narrower in children than in adults.

The preanesthetic medication is equally as essential in anesthetizing children as adults.

The psychological approach to anesthesia in children should not be minimized as it is a most important factor in obtaining smooth anesthesia.

The choice of anesthetic should be that which is best suited to the individual.

The positioning of patient before being anesthetized lessens the possibility of undesirable changes in the circulatory and respiratory systems.

Operating room hazards should be regarded very seriously by the anesthetist when administering combustible anesthetic mixtures in the presence of electrostatic spark. It is the responsibility of the anesthetist to see that the necessary precautions are observed to prevent a possible accident.

The recovery room furnishes efficient postanesthetic nursing care to the patient, with essential equipment immediately available.

Teamwork is the keynote in the successful administration of an anesthetic.

Pulmonary Physiology: Its Significance in Anesthesia for Thoracic Surgery

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"The more the physiology of anesthesia is studied the more striking becomes the predominance of the part played by respiration. Indeed, the physiology of respiration may be said to dominate the physiology of anesthesia."

This quotation from a paper by Gordh serves as a reminder, once again, how vitally important an understanding of the physiology of the respiratory system is to all who administer anesthesia.

It is, of course, impossible to cover the entire field of pulmonary physiology in a single article. However, there are many significant alterations in pulmonary function which occur as a result of anesthesia and surgery and I would like to present a few of those which are of concern in the management of anesthesia for an intrathoracic procedure.

Among the first problems to arise, even before surgery is begun, are those of increase in resistance to respiration and increase in dead space air. All of the anesthesia machines in use today increase the resistance to respiration somewhat. It is, of course, important to keep this increase at an absolute minimum for the greater the resistance to respiration the greater is the physical effort required of the patient to move gases in and out of the lungs. This increased workload in a patient undergoing a major intrathoracic procedure may spell the difference between success and failure and it is particularly in children that this problem of resistance becomes most serious.

There are many causes for increased resistance to respiration during anesthesia but the factor which influences resistance most is the size of the openings between the masks, canisters, breathing bags and intratracheal catheters. Using small intratracheal catheters in large patients will increase the resistance to respiration as will the use of any connector which narrows the lumen of the channel through which the gases must pass.

The problem of dead space is, like resistance, the result of the use of the modern anesthesia apparatus. The total dead space in any system is the sum of the mechanical dead space and the anatomic dead space. Mechanical dead space is the name applied to that volume of gases which is reinhaled without being freed of its carbon dioxide. It consists of gas which does not come into contact

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with soda lime before being reinhaled. The volume of air in the face mask or in any tubing or connecting pieces between the face mask and soda lime canister makes up the mechanical dead space in any system. In addition, in the to-and-fro system the intergranular air space between particles of exhausted soda lime also adds to the mechanical dead space.

The anatomic dead space is the volume of air which fills the pharynx and trachea and, though it moves in and out of the respiratory tract with each cycle, it does not come into contact with the alveolar membrane and thus does not enter into the process of gas exchange in the lungs.

The greater the dead space the less efficient will be the removal of carbon dioxide from the gases within the system and carbon dioxide excess may be the result. Therefore, every effort must be made to keep the dead space at a minimum.

The use of the intratracheal catheter is a great aid in minimizing the danger of excessive dead space. By excluding the volume of air in the pharynx from the system and by eliminating the need for a face mask it reduces both anatomic and mechanical dead space. The use of excessively large face masks and unnecessary tubing must be avoided if we are to prevent the accumulation of carbon dioxide. In pediatric anesthesia this problem of dead space assumes even larger proportions for children are far more susceptible to the effects of excess carbon dioxide. From the standpoint of dead space alone, the ideal anesthetic is insufflation of anesthetic gases or vapors with oxygen and consequently this technique is widely used in pediatric anesthesia today.

Since, as we shall see, the danger of carbon dioxide accumulation is a very real one in intrathoracic surgery a knowledge of the effects of increased dead space is a great aid in the management of these cases.

Another problem which presents itself early is that of the effects of positioning upon the patient's respiratory function. Any position which limits the expansion of the thoracic cage results in underventilation of the lungs and thus leads to oxygen want and carbon dioxide accumulation. The lateral position which is the one most commonly used for thoracic surgery does exactly that. The patient is placed on his side with the diseased lung uppermost. This results in compression of the good lung and restricts the functioning of the intercostal muscles. In addition, the patient is often placed in the head-down position to facilitate the drainage of secretions and this throws the abdominal viscera up against the diaphragm further compressing the lung and preventing adequate excursion of the diaphragm. In the obese patient and in those patients with extensive destruction of pulmonary tissue the adverse effects of positioning alone have occasionally prevented the operative procedure from being carried out. The use of elevating rests along with the lateral position or flexing of the operating table merely aggravate the situation and are mentioned only to be condemned.

Thus it is that even before the surgeon makes his incision there are definite alterations in respira-

tory physiology taking place merely as the result of the apparatus being used and the position of the patient. If these changes are not recognized and compensated for by the anesthetist the success of the procedure is placed in jeopardy at the very outset. Measures which can be taken include the use of intratracheal catheters, connectors, and other equipment of a size designed to minimize resistance to respiration and prevent a significant increase in dead space, the avoidance of extreme positions, and the use of assisted respiration to insure adequate ventilation of the compressed pulmonary tissue.

Now let us turn to the problems which arise as a direct result of the operative procedure. Up until the instant that the surgeon's knife opens the pleural space the movement of gases in and out of the lungs is regulated by a delicately balanced system of pressure changes between the intrapleural and intrapulmonary spaces.

Normally the intrapleural pressure, the pressure in the space between the chest wall and the lungs, is negative at all times. It fluctuates between −10 mm. Hg during inspiration and −5 mm. Hg during expiration.

The intrapulmonary pressure, that is the pressure within the lungs, follows the changes in the intrapleural pressure as long as the pleural space is intact. With the beginning of inspiration the size of the thorax is increased and the intrapulmonic pressure falls 2 to 3 mm. Hg below atmospheric. Since the intrapulmonary space is in contact with the atmosphere through the respiratory passage air moves into the lungs. During expiration the reverse of this process takes place. The size of the chest is decreased, the intrapulmonic pressure rises to 2 to 3 mm. Hg above atmospheric and air moves out of the lungs.

The opening of the pleural space, however, destroys this balance between the intrapleural and intrapulmonary pressures. The negative pressure surrounding the lung is replaced by atmospheric pressure, the lung collapses and the mediastinum and its contents are sucked to the opposite side. With each respiratory cycle the mediastinum swings back and forth disturbing the heart and great vessels and during inspiration some air is sucked out of the collapsed lung into the good lung resulting in a decrease of fresh air entering the lung through the trachea (paradoxic respiration).

The result of this profound alteration in pulmonary physiology is obvious. The lungs will be poorly ventilated resulting in suboxygenation of the patient and inadequate removal of carbon dioxide. It is the responsibility of the anesthetist to correct this situation and in order to do so some form of pulmonary control must be instituted.

There are three principal methods of pulmonary control: positive pressure respiration, assisted (compensated) respiration, and controlled respiration. Each of these methods has a place but each also has its advantages and disadvantages. Most of the disadvantages of these methods stem from the fact that none of the three can duplicate the normal physiologic mechanism for ventilation of the lungs.

Positive pressure respiration

(the application of positive pressure during both inspiration and expiration) has the most detrimental effect of the three.

Normally the flow of venous blood to the heart reaches its peak during inspiration. This is due to the increase in the negative intrapleural pressure plus the milking effect on the abdominal veins which occurs as a result of the descent of the diaphragm.

When positive pressure respiration is instituted, however, the increase in the intrapleural pressure which occurs diminishes the venous return to the heart during both inspiration and expiration. This leads to a reduction in cardiac output and a corresponding fall in blood pressure; a very undesirable situation in a patient undergoing a major and oftentimes shocking procedure. In addition to this, positive pressure respiration has the effect of actually decreasing ventilation of the lungs as the pressure on expiration prevents complete emptying and secretions are often forced into the smaller bronchi leading to plugging of these structures and atelectasis. For these reasons positive pressure respiration should be used for short periods only and only when specifically indicated, i.e., when the pleura is first opened to prevent sudden collapse of the lung and in order to remove the residual pneumothorax when the chest wall is being closed.

Assisted (compensated) respiration and controlled respiration differ from positive pressure respiration in that pressure is applied intermittently and only during inspiration. These types of respiration have less effect upon the circulation and it has been found that the influence of intermittent positive pressure depends upon the shape of the pressure curve. The best results and the least untoward effect to the patient are obtained when the pressure is allowed to drop rapidly to atmospheric at the end of the inspiratory phase and the expiratory phase is of sufficient duration to permit enough heart beats to compensate for the period of reduced output which occurs during inspiration when the pressure is applied. The duration of the expiratory phase should be at least as long as that of inspiration.

While there is some difference of opinion as to whether assisted or controlled respiration is the best the basic aim of both these methods is the same; that is, to provide adequate ventilation of the lungs.

To further emphasize the importance of maintaining adequate ventilation of the lungs reference is made to the work of Draper, Whitehead, and Spencer[1] on diffusion respiration and that of Beecher[2] on carbon dioxide accumulation during thoracic surgery.

In 1944, Whitehead and Draper demonstrated that, in the presence of an adequate airway, effective denitrogenation and a high concentration of oxygen, oxygenation could be maintained during pentothal induced apnea in dogs. They described an oxygen-hemoglobin pump to account for this and named the process diffusion respiration.

1. Draper, W. B.; Whitehead, R. W., and Spencer, J. N.: Studies on diffusion respiration. Alveolar gases and venous pH of dogs during diffusion respiration. Anesthesiology **8**:524-533 (Sept.) 1947.

2. Beecher, H. K., and Murphy, A. J.: Acidosis during thoracic surgery. J. Thoracic Surg. **19**:50-70 (Jan.) 1950.

However these same investigators also found that, in the absence of pulmonary ventilation, the concentration of carbon dioxide in the alveoli of the lungs rose to narcotic levels (average value 54.7%) within 45 minutes and they postulated that ultimately carbon dioxide might completely exclude oxygen from the lungs.

Thus, while it is possible to supply sufficient oxygen to the pulmonary capillaries during periods of respiratory depression it is impossible to remove carbon dioxide without adequate pulmonary ventilation.

Beecher in his studies on patients undergoing intrathoracic procedures further demonstrated this fact. He found that while oxygenation was satisfactory in those patients whose respirations were not assisted, the carbon dioxide concentration rose to very high levels indeed.

The dangers of carbon dioxide accumulation are ever present, and thus the problem of providing some means for efficient pulmonary ventilation will always be a vital one.

Endobronchial Anesthesia

Although intratracheal anesthesia has proved satisfactory for the management of intrathoracic surgery, many anesthesiologists feel that this method does not offer the best possible operating conditions or maximum safety for the patient in certain types of cases. Patients who have a bronchopleural fistula, lung abscess, lung cyst, or severe bronchiectasis with large amounts of secretions are in constant danger of drowning or contamination of the good lung in spite of the use of an intratracheal catheter. Endobronchial anesthesia has been advocated as the answer to this problem.[3, 4]

The method of one-lung anesthesia was described in 1932 by Gale and Waters and since that time many methods for performing endobronchial anesthesia have been developed.

Bronchial plugs, cuffed tubes and double lumen catheters have all been successfully employed and have provided the results desired, namely, a quiet operative field with good exposure and protection of the good lung from contamination.

However, the use of this technique is not entirely without danger. When the operative side is sealed off during endobronchial anesthesia, the lung soon deflates as the air in the alveoli is absorbed without being replaced. This results in excellent exposure for the surgeon but raises two important questions concerning the patient's ultimate well-being.

It has long been an accepted procedure in the management of thoracic surgery that the lung being operated upon be reinflated at intervals during the procedure. It is felt that this is desirable for the lung may not re-expand completely following long periods of collapse. During endobronchial anesthesia, the lung remains collapsed for long periods of time and the danger of incomplete expansion must be considered. For this reason alone some have advised that endobronchial anesthesia be employed only when pneumonec-

3. Bonica, J. J., and Hall, W. M.: Endobronchial anesthesia for intrathoracic surgery. Anesthesiology 12:344-365 (May) 1951.

4. Björk, V. O.; Carlens, E., and Friberg, O.: Endobronchial anesthesia. Anesthesiology 14:60-71 (Jan.) 1953.

tomy is contemplated. More experience with the technique may prove this danger to be overemphasized and the use of the double lumen catheter may eliminate it as a problem for with this technique the lung can be expanded at intervals, if necessary. However for the present it remains a potential hazard.

The second abnormal situation which occurs as a result of the use of endobronchial anesthesia is due to the fact that when one lung is suddenly deflated the same amount of blood passes through the nonventilated lung and is returned to the heart without being oxygenated. It has been demonstrated that the blood flow through the collapsed lung does not decrease for many hours. An arteriovenous shunt is thus created. The larger the shunt (the more unoxygenated blood that is returned to the heart) the greater will be the decrease in the oxygen saturation of the arterial blood.

The effect that the creation of this shunt has on the patient depends in large extent upon the condition of the nonventilated lung. In a severely diseased lung the blood flow through the pulmonary artery is decreased and the healthy lung has taken over most of the function of the diseased side. Therefore the shunt created by collapsing the diseased lung has little effect.

In other cases, however, when the lung to be collapsed contains large amounts of healthy pulmonary tissue the effect of the shunt can be considerable.

The clinical significance of this arteriovenous shunt is obvious. It means that one-lung anesthesia cannot be carried out in cases where the function of the nonoperated side is just sufficient to maintain adequate oxygenation of the patient. In this type of case the added effect of the shunt may reduce the degree of oxygen saturation of the arterial blood to unsafe levels.

This discussion of endobronchial anesthesia should emphasize that this technique is not a substitute for intratracheal anesthesia but rather should be reserved for selected cases where it offers definite advantages.

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Endocrine Physiology in Relation to Anesthesia

John E. Cann, M.D.*
San Francisco

The products of the ductless glands—such as the adrenals, the thyroid, the pituitary—belong to a class of physiologically active chemical substances known as hormones. Hormones are chemical substances which having been formed in one part of the body are carried by the blood stream to another organ and influence its activity. The glands forming hormones are known as the endocrine glands.

Apart from small amounts that may be held in the endocrine organs themselves, hormones are not stored in the body. Therefore, in cases of endocrine deficiency, repeated small doses rather than large doses at infrequent intervals are required to correct the deficiency.

In general, the hormones of the sex glands and adrenal cortex are steroids chemically and are closely allied in chemical structure, while the active principles of the pituitary, thyroid and parathyroids are proteins.

With the exception of the secretion of the thyroid, gonads and adrenal cortex, the various hormone preparations which so far have been obtained by extraction and employed in medicine are almost entirely or quite inert when administered orally. Even though the sex hormones and the principles of the adrenal cortex are effective by oral administration, the dose when given in this way must be much larger than if given parenterally in order to produce the same response.

In actual practice, patients with disease of the pituitary gland of such a nature as to affect the anesthesia course are seldom seen. It should be pointed out, however, that pituitrin and pitressin cause coronary constriction, and potentially a resultant myocardial hypoxia. Cases of so-called "pituitrin shock" have been reported following the administration of the drug to patients under anesthesia.[1]

Deficiency of the product of the thyroid gland is, of course, associated with a reduced basal metabolic rate. Clinically these patients may present the picture of cretinism or myxedema. Myxedematous patients may have an enlarged heart with a low voltage ECG. These patients show an in-

Read before the Twentieth Annual Meeting of the American Association of Nurse Anesthetists, San Francisco, August 31, 1953.

*Anesthesiologist.

1. Parsloe, C. P.; Morris, L. E., and Orth, O. S.: The relationship of various anesthetic agents to the action of pituitrin, pitressin and pitocin. Anesthesiology 11:76-93 (Jan.) 1950.

creased susceptibility to depressant drugs, and they should be adequately treated with thyroid extract before any surgical or anesthetic procedure.

Subjects of hyperthyroidism present the opposite picture of an increased basal metabolic rate, and as such are particularly susceptible to oxygen deficiency. Work is performed less economically and dyspnea occurs on only slight exertion. Cardiac hypertrophy and ultimate failure is probably simply the result of the increased work thrown on the myocardium.

So-called "thyroid crises" with nausea, vomiting, diarrhea, dehydration, high temperature, a great increase in the heart rate, extreme nervousness, muscular weakness, and sometimes delirium and coma, are rarely seen in these days. Such a crisis may occur after operation and death result from exhaustion or cardiac failure. If the patient has been adequately prepared preoperatively, the danger of such a crisis is reduced to a minimum.

Iodine in the form of Lugol's solution is invaluable in the treatment of exophthalmic goiter; hyperplasia gives place to the picture of colloid goiter, the symptoms abate, and there is a pronounced fall in the basal metabolic rate.

Thiourea and thiouracil lower the metabolic rate and have come into use in the treatment of thyrotoxicosis. These drugs apparently act by preventing the synthesis of thyroxine by the thyroid. They have a twofold action; they stimulate the production or liberation of thyrotrophin by the pituitary which accounts for the thyroid hyperplasia, and also interfere with the production or the liberation of thyroxine. This latter effect explains the hypothyroidism and may be the primary and only direct action of these drugs.

Regional analgesia for operations on the thyroid must include bilateral deep and superficial cervical plexus block, together with intradermal and subcutaneous infiltration of the line of incision. Even if general anesthesia is to be used, some surgeons like infiltration of the line of incision with an adrenaline solution to avoid wound oozing. As adrenaline is sometimes poorly tolerated in thyrotoxicosis, it should be used with caution in these patients. Again, some surgeons advocate the use of other vasoconstrictor drugs that do not affect the myocardium to the degree that adrenaline does.

Bad signs in the preoperative preparation of the hyperthyroid patient are: (1) failure of the pulse rate to become less than 100; (2) auricular fibrillation; (3) history of previous heart failure; (4) failure to gain weight under medical treatment; (5) prolonged existence of the disease; (6) vomiting and diarrhea.[2]

All the commonly used agents have their advocates for anesthesia in cases of hyperthyroidism. Some use cyclopropane routinely, others fear it in the presence of cardiovascular abnormality.

Some prefer intratracheal airways; others are against them. Intratracheal tubes prevent respiratory obstruction and hypoxia, without their use postoperative tracheitis and mucous collection is avoided and a lighter plane of anesthesia is possible. If an ade-

2. Mousel, L. H., and Coakley, C. S.: Anesthetic management of the patient with thyroid disease. Anesthesiology 10:444-450 (July) 1949.

quate airway can be maintained with an oral or nasopharyngeal technique, an intratracheal tube is better avoided.

In general, the substance produced in the adrenal medulla—adrenaline—imitates almost perfectly the effects evoked by stimulation of the sympathetic system. The effects of adrenaline administration, for instance, do not persist for more than a minute or two. When given orally, adrenaline is inert. In clinical doses, adrenaline causes constriction of the arterioles and capillaries of the skin, mucous membranes, and splanchnic viscera; the vessels of the muscles at the same time dilate as do the coronary vessels. Thus, there occurs a redistribution of blood, which is moved from the splanchnic area and skin to the skeletal and cardiac muscles.

Adrenaline quickens the heart rate and greatly increases the oxygen consumption of the cardiac muscle.

Clinically, patients with a tumor of the adrenal medullary tissue or pheochromocytoma demonstrate an example of hyperadrenalism, and they present distinct problems in anesthesia when they come to surgery.

Four main problems present themselves: (1) adequate muscle relaxation; (2) possibility of pneumothorax occurring from surgical manipulation; (3) effects of excessive secretion of epinephrine; (4) the sudden circulatory depression that may occur after excision of the secreting mass.

Ether and an intratracheal technique of anesthesia will adequately manage the first two problems.

Agents which, in the presence of adrenaline, produce serious ventricular arrhythmias should be avoided, such as cyclopropane, chloroform, and ethyl chloride.

Piperoxan hydrochloride (20 mg. or more) is used intravenously to combat paroxysmal hypertension. The hypotension and circulatory collapse following excision of the tumor is best controlled by an intravenous drip of a dilute solution of neosynephrine or nor-epinephrine. A dilute solution of vasopressor drug may have to be used for several days postoperatively until the patient becomes stabilized.

Adrenaline is useful in anesthesia to prolong the effects of nerve blocks and spinal anesthesia.

The adrenal cortical secretion, unlike that of the medulla, is essential to life. However adrenalectomized animals treated with cortical extracts have survived indefinitely. Some twenty crystalline steroid compounds have been isolated from the adrenal cortex which exhibit in greater or less degree the physiological properties of crude cortical extracts.

An animal which has been completely adrenalectomized shows the following features during the short period of its survival. Loss of appetite, vomiting, diarrhea, rapid loss of weight, weakness and prostration, fall in body temperature, hypotension, and a reduction in basal metabolic rate. The blood becomes concentrated and shows a fall in sodium and sugar, phosphate, calcium, and especially potassium. There are reduced excretion of urinary nitrogen and other signs of renal failure. The glycogen stores of the liver and muscles are reduced.

The foregoing picture can be completely prevented by the administration of an extract of the cortex. The cortex evidently is concerned with water metabolism and with metabolism of potassium and sodium. In adrenal insufficiency in man, a reduction in total base occurs which is due entirely to the loss of sodium. The loss of sodium due apparently to diminished reabsorption by the renal tubules is accompanied by an increased elimination of water and resulting dehydration. The administration of sodium chloride to adrenalectomized animals and a reduction in the potassium intake exert a definitely beneficial effect.

Papper and Cahill[3] reported on 19 patients with Addison's disease subjected to anesthesia and surgery or obstetrical delivery. Among five patients subjected to anesthesia and surgery and not recognized as cases of Addison's disease, one died on the operating table, two died following postoperative circulatory collapse and operation was cancelled for one because of uncontrollable hypotension during anesthesia. The fifth patient suffered a severe postoperative circulatory collapse but recovered. None of these patients was prepared with sodium chloride or specific hormone therapy prior to anesthesia and operation.

Fourteen patients whose disease had been diagnosed were prepared with adequate doses of desoxycorticosterone acetate and/or adrenal cortex extract and sodium chloride before operation.

In the properly prepared patients, premedication appeared satisfactory and did not produce undue depression. In fact, difficulty with depressant drugs was observed only in the patients whose disease was unrecognized prior to the administration of anesthesia.

Various anesthetic agents and techniques were used. A thorough analysis of the physiological changes that occurred during anesthesia or in the postoperative period demonstrated comparatively little relationship between the anesthetic agent or technique employed and the complications that arose.

The single greatest complication that occurred during anesthesia or postoperatively was hypotension. There was no specific relationship between hypotension and the type of anesthesia employed. The hypotension was managed by the intravenous administration of water soluble whole adrenal cortex extract, whole blood or plasma. The maintenance of satisfactory arterial blood pressure appeared to be a most useful clinical guide to the administration of adrenal cortex extract as well as parenteral fluids.

Two patients showed fluid retention, edema and definite evidence of congestive heart failure postoperatively. These patients had received excessively large doses of desoxycorticosterone acetate and the edema and congestive failure disappeared only when the drug was withdrawn.

A specific relationship could not be established between the precipitation of Addisonian crisis and the anesthetic agent or operative procedure. There was also little doubt that circulatory col-

3. Papper, E. M., and Cahill, G. F.: Anesthetic problems in hormonal disorders of the adrenal glands. J.A.M.A. **148**:174-179 (Jan. 19) 1952.

lapse was the most dangerous and the most frequent complication, and that it occurred regardless of the type of anesthesia and operation.

Lundy[4] points out that cortisone and corticotrophin are in such wide use today for a number of maladies that an increasing proportion of patients are going to be appearing for anesthesia and surgery who will demonstrate an unrecognized depressed adrenal cortical function.

A common characteristic of circulatory collapse among patients who at some time previous to operation have been treated with cortisone or ACTH, but who have not received it preoperatively, during and after operation, is that circulatory collapse occurs at the time of operation or up to 24 to 36 hours after operation. Another characteristic is that the onset of the shock is sudden and extreme, and there is little or no time in which to combat it after it has begun.

Patients with this type of shock can be supported temporarily with solutions of "plasma expanders." These are only temporary measures; such conditions are better treated prophylactically.

The most satisfactory schedule for preparing for anesthesia and operation consists of the intramuscular administration of 100 to 200 mg. of cortisone per day for two to three days before operation and again on the day of operation. A similar schedule also may be used for two to three days postoperatively; after that, the dose should be gradually reduced until it reaches an optimal figure previously established.

In cases of absolute emergency, no such schedule can be carried out. It is imperative to find out if these cases have been on cortisone or ACTH. In such emergencies, about 30 to 50 cc. of adrenocortical extract injected intravenously and repeated as needed, in addition to resumption of the use of cortisone or ACTH, has been employed to maintain the unprepared patient safely during the period of stress, so that he may be assured of the support necessary for survival.

4. Lundy, J. S.: Cortisone problems involving anesthesia. Anesthesiology 14:376-381 (July) 1953.

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Notes and Case Reports

Unusual Complication from Use of a Nasal Airway: A Case Report.—A few reports have been published describing mucosal injuries from the use of an endotracheal tube[1, 2, 3, 4] but no reports of laceration of the pharynx from the use of a nasal airway have come to our attention. The following is the report of such a case:

An obese woman, 36 years of age, was admitted to the hospital for abdominal hysterectomy. The physical examination revealed no abnormality in the upper respiratory tract, such as sinusitis, nasal polyps or deviated septum.

Premedication was morphine sulphate 10 mg. and atropine sulphate 0.4 mg. given 45 minutes prior to arrival in the operating room. The patient was anesthetized with nitrous oxide, oxygen and ether. When all attempts at correcting an obstructed airway were unsuccessful, a nasal airway was inserted under very light anesthesia. A No. 30 French airway was inserted into the right nostril but obstruction prevented advancement beyond approximately 3½ cm. The airway was then inserted into the left nostril without difficulty but epistaxis began shortly thereafter. The nasal airway was removed and a rubber airway was substituted but bleeding persisted for fifteen minutes. After this period of time the patient began secreting mucus which was tinged with blood. Atropine sulphate 0.4 mg. was given intravenously but bloody mucus persisted throughout the 1½ hour operative procedure.

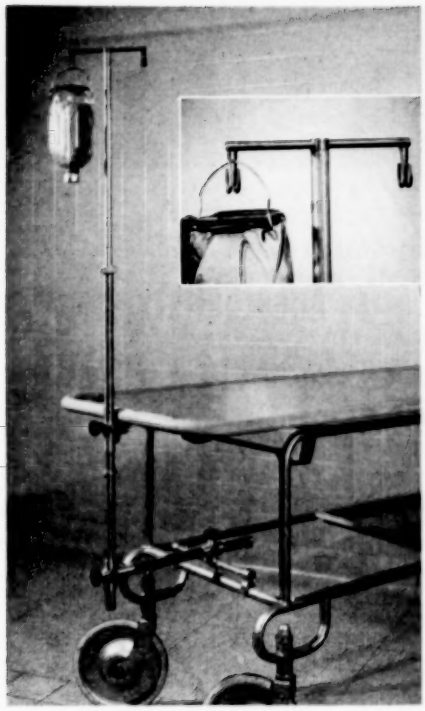
A laryngoscopy was done at the conclusion of anesthesia, which revealed a laceration in the posterior pharyngeal wall which resembled one made by a knife. The nasal airway was reinserted for the purpose of finding the cause of the trauma. The tip of the airway just touched the cephalad part of the mucosal slit. The oral airway was then inserted but this airway did not reach the mucosal tear.

Plain 00 catgut was used to close the traumatic incision, which was approximately 2 cm. in length and 0.7 cm. in depth.

The postoperative course was uneventful except for a slight sore throat for the first 24 hours.—**Robert A. Hingson, M.D., and Christine Costley, R.N.,** University Hospitals of Cleveland.

1. Intubation hazards. Morbidity Conference. Brit. J. Anaesth. **24**:147-148 (April) 1952.
2. Brown, W. M.: Blind intubation. Anaesthesia **7**:118 (April) 1952.
3. Daly, W. M.: Unusual complication of nasal intubation: report of case. Anesthesiology **14**:96 (Jan.) 1953.
4. Gilles, J.: Endotracheal methods: their use and abuse. Anesth. & Analg. **30**:343-347 (Nov.-Dec.) 1951.

Infusion Carrier for Stretchers.—This apparatus is designed to support infusion flasks containing various liquids on invalid mobile stretchers, so that the operation of administering infusions to patients may be carried on while the patient is being transported



Infusion carrier for stretchers (patent pending).

from surgery to a recovery room without an extra attendant being present.

The carrier is readily adjustable and attachable to various types of invalid stretchers, such as the slated or solid tops, also the tubular and angular type. The apparatus is sturdy and rigid, has adjustable elevation, and is simple and easy to attach to any part of a mobile stretcher.

The unique double locking safety hooks for mounting solution flasks, standard equipment on this type of carrier, are sturdy and positive in action. When the flasks are placed in these hooks they will not jar loose or become dislodged regardless of the motion of the stretcher. — **Josephine E. Krewson, R.N.,** Muskegon, Mich.

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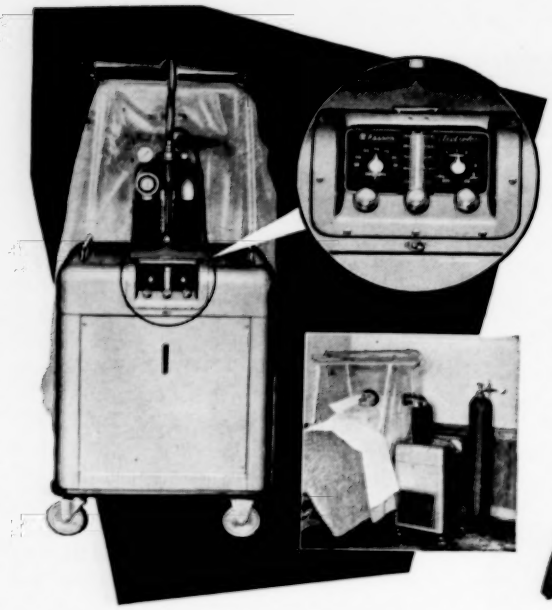

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Legislation

Absence of Bed Rails, and Patient's Fall From Bed, Held Insufficient Proof of Negligence.[1]—The hospital, a practical nurse employed by the hospital, and two physicians were sued by an 80-year-old patient for injuries sustained by her when she fell from the bed.

She had been admitted to the hospital by ambulance after having suffered a stroke which resulted in a paralysis of the left side of the face and which prevented her from swallowing. She had control over both her arms and legs. Her physicians gave instructions to the hospital over the telephone and the directions were placed on the patient's hospital chart.

At the hospital, the practical nurse awakened her that night and told her to wash from a basin placed at the right of the bed. To reach the basin the patient had to change her position. She sat up, swung both her legs over the side of the bed, and in so doing, slipped off the edge of the bed and fell to the floor, suffering a fractured left hip.

The doctors were charged with negligence in failing to instruct the hospital employees to install bed rails on the bed. Her claim against the hospital and the nurse was that the bed was not equipped with bed rails and none were installed; she was negligently ordered to wash herself.

The case was dismissed by the court. No expert medical testimony had been produced to show the doctors were negligent in not instructing the hospital to use bed rails. The patient was fully aware of what she was doing. There must be proof that she was in a helpless condition which was known to the nurse and the hospital, and that reasonable care under such circumstances required the installation of the bed rails. That the bed was not equipped with bed rails is not, in itself, evidence of negligence. The evidence of negligence was insufficient to warrant the submission of this issue to the jury.

Question of Liability of Hospital or Physician for Negligence of Operating Room Nurse Held for Jury to Determine.[2]—Negligence of the hospital and a nurse was alleged by the patient, which resulted in personal injuries to her in the operating room. She had been placed upon an operating table and given a "spinal block" by her physician. After administering the anesthetic, he left her in charge of the nurses and went into an adjoining room to scrub his hands in preparation for the

1. Cochran v. Harrison Memorial Hospital, 254 P. 2d, 752, Wash.

2. McCowen v. Sisters of the Most Precious Blood of Enid, *et al.*, 1 C.C.H. Neg. Cases (2d) 1112; Oklahoma Supreme Court—Feb. 10, 1953.

operation. During his absence, and without any instructions from him but in line of duty, the nurse proceeded to place the patient's legs in stirrups. When the drop leaf of the table was let down, the entire weight of the lower part of her body was supported by the stirrups. It was then observed that the stirrups were improperly attached, or were in reverse order. Without raising the drop leaf end of the table, the nurse proceeded to change the stirrups and in doing so permitted the patient to slide forward over the end of the table.

The trial court dismissed the case against the hospital on the ground that the nurse in the operating room becomes the responsibility of the surgeon, even though she is an employee of the hospital. During the trial a remark was made by the patient's attorney to the jury which was calculated to convey the impression that the nurse was protected against loss and the jury should therefore render a large verdict.

On appeal, the dismissal against the hospital was reversed and a new trial ordered. It was held that the trial court should have submitted to the jury the question of whether the nurse in the operating room, under the particular disputed circumstances, was to be considered the agent of the hospital or of the physician. Disputed questions of facts are decided by the jury; the court decides only questions of law. In view of the prejudicial remarks of the attorney at the trial, a new trial was ordered for the nurse.

Anesthetist and Oral Surgeon Not Liable for Patient's Tooth Lodging in Lung.[3] — The patient was advised to have all her remaining teeth extracted. At the hospital, an anesthetic was administered and during this process one of her upper front teeth became dislodged and found its way into one of her lungs. It was necessary for an expert to remove the tooth from the lung with the use of a bronchoscope.

She sought to recover damages from the physician and the anesthetist. After a lengthy trial, her suit was dismissed. The court said that, since it was oral surgery which was to be performed, it was necessary that some method of administering the anesthetic be resorted to which would leave the mouth unobstructed. Insofar as the anesthetist was concerned, there was no negligence on her part. She followed procedure which was normal and employed by others in the community skilled in that particular profession. Both she and the doctor did all that reasonably careful practitioners, skilled in their respective professions, could have done. "Ordinarily the physician, the surgeon, or the dentist is held to be not liable for undesired or unexpected results if it is shown that he possesses and exercised such skill and knowledge as are possessed and exercised by others in good standing practicing in similar localities."

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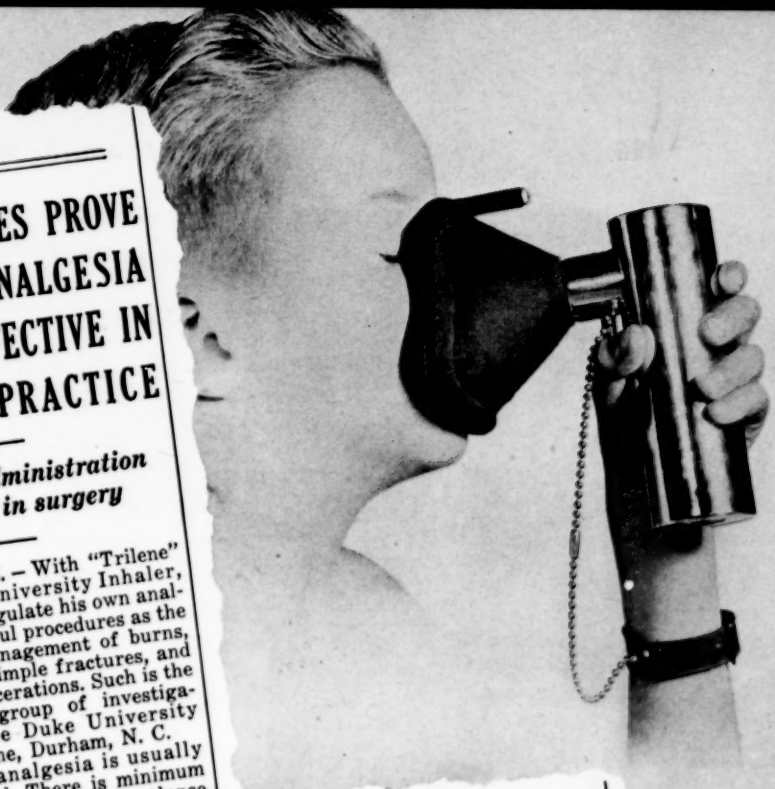
3. Meyer v. St. Paul Mercury Indemnity Co. of St. Paul, Minn., *et al.*; Louisiana Court of Appeal, January 8, 1953—2 C.C.H. Neg. Cases 2d 76.



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1. Stephen, C. R., Nowill, W. K., and Martin, R.: Anesthesiology *13*:646 (Nov.) 1952.

2. Pickrell, K. L., Stephen, C. R., Broadbent, T. R., Masters, F. W., and Georgiade, N. G.: Plast. & Reconstruct. Surg. *9*:345 (Apr.) 1952.

For further information on "Trilene" and the "Duke" University Inhaler (Model-M), please write to Ayerst, McKenna & Harrison Limited, 22 East 40th Street, New York 16, N. Y.

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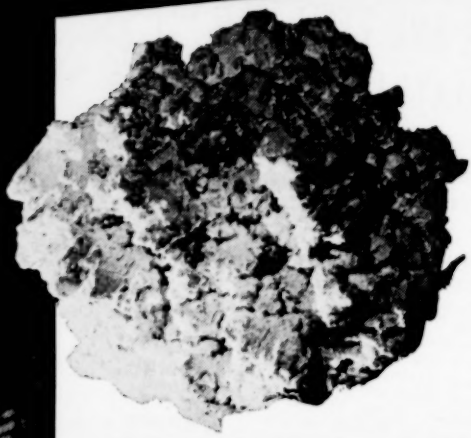

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Abstracts

Nilsson, E.: The application of a method for the investigation of cerebral damage following anaesthesia using controlled hypotension; a preliminary communication. Brit. J. Anaesth. **25**:24-31 (Jan.) 1953.

"No clinical test of cerebral function has been performed during voluntary induced hypotension, but in the literature it has been stated that clinically no cerebral changes have been observed. Berg in 1949 reported a method of measuring the functional capacity of the normal cerebrum and after cerebral injuries of a traumatic, toxic or infectious nature. He employed for the purpose of his investigation the 'flicker fusion method'. . . . In his tests Berg used a variable light intensity. . . . In order to enable him to deal with whole numbers, Berg has introduced a unit which he calls a 'filter unit' (Fu). The light intensity stated in 'filter units' expresses how many times the standard intensity must be reduced to cause fusion. . . .

"The test is performed with the patient in a sitting position. First a careful initial value is obtained. After this the hexobarbitone is given, and two minutes later the first determination is made; subsequently, fusion values are determined every other minute. A curve is thus obtained, in which is seen not only how deep is the drop in fusion value but also for what length of time the fusion value remains below normal. . . . The degree of severity of the cerebral injury is directly proportional to the depth and length of the curve, and moreover it is directly proportional to the number of days after the injury during which the test is still positive. . . .

"Up to now we have used the negative cases as controls, but will, of course, later investigate an equivalent control series, which has been exposed to anaesthesia but not to intentional hypotension. Our interest has been especially directed to those cases in which we have induced a bloodless operative field by combining block of the autonomic nervous system with a raised head-end of the operating table, a situation in which a certain degree of cerebral anaemia must be expected. Since the investigation was begun 15 patients have been followed up during their postoperative period with daily flicker fusion tests. Of these 15 patients . . . 6 have shown a positive test signifying cerebral injury. Of the 6 with positive tests 5 had been lying during the operation and anaesthetic with the head-end of the table raised between 10 and 20 degrees. One of the patients with a positive test was operated in the lateral position with the operating table horizontal. . . . The injuries were not severe but resembled concussion. Repeated trauma to the brain of this nature might lead to severe and irreversible damage. It is therefore our opinion that the indi-

cations for using the technique with controlled hypotension and postural ischaemia must be very clear and each case carefully evaluated."

COLE, F.: Water accumulation as a hazard of rebreathing in anesthesia. J.A.M.A. **151**:910-913 (March 14) 1953.

"In the closed system of administering anesthesia, the patient is required to breathe into the machine and to inhale, unless modifications of the gaseous mixture are brought about, what he has previously exhaled. During respiration, the air is changed in three ways that might prompt one to modify the mixture before rebreathing: the oxygen content is reduced, the carbon dioxide concentration is elevated, and the amount of water is increased. There is no difference in the absolute amounts of nitrogen or argon inhaled and exhaled. A fourth and entirely physical change is the increase in the temperature of the air, resulting from air being drawn into the lungs and from gas, particularly carbon dioxide, being removed from the blood. Gases are exhaled at approximately body temperature. In order to counteract the first two changes, oxygen is added to maintain a constant level and contact with soda lime is employed to remove the excess of carbon dioxide, so that the exhaled air is no longer considered vitiated or noxious and is generally felt to be suitable for rebreathing. At the same time, anesthetic substances are added. Since no provision has been made for the large increase in water content, the patient is made to breathe a mixture that is soon saturated with water vapor. . . .

"There is no compensation by the patient or by the anesthesia apparatus for this hazard of water retention, water accumulation, and heat retention. On the contrary, a classic vicious circle may exist. . . . The presence of an excess of water may dilute the oxygen and produce anoxia, dilute the anesthetic gas and preclude proper anesthesia, cause respiratory obstruction, produce pulmonary edema or atelectasis, interfere with water loss from the body, and curtail proper heat loss and cause a rise in body temperature. . . .

"It is suggested that attempts be made to draw off the liquid water always present in the breathing tubes and bag on the anesthesia machine, and that efforts be made to remove water vapor from gaseous mixture in the machine. For the latter purpose, the use of various dehydrating chemicals is advised, i.e., anhydrous salts as copper sulfate, solid carbon dioxide, concentrated sulfuric acid, calcium chloride, and silica gel. Some of these are obviously unfit for use, but calcium chloride and silica gel appear to be suitable substances. The drying agent should be exposed to the gases in the same manner as soda lime is for the absorption of carbon dioxide. While these attempts are now being made, other measures may also be advisable. They include cooling the apparatus to reduce the water vapor content of the atmosphere and to permit proper heat loss from the body, a search for an agent or method that will absorb carbon dioxide without the liberation of heat and the formation of water, and a reevaluation of the carbon dioxide absorption method

of giving anesthesia in which the patient is made to breathe for hours a water-soaked atmosphere at a temperature as high as 107.6 F."

Koffler, A.: Allergic skin reaction to procaine amide hydrochloride. Report of a case. J.A.M.A. **152**:28 (May 2) 1953.

"Procaine amide (Pronestyl) hydrochloride has been used effectively in the treatment of cardiac arrhythmias of ventricular origin. . . . Until recently procaine amide hydrochloride was considered to be a drug free of serious side-reactions. . . . Recently, however, severe and even fatal side-reactions have been noted to occur with the use of procaine amide hydrochloride. Among the untoward reactions published were agranulocytosis, fatal ventricular fibrillation, ventricular acceleration, fever, and allergy to procaine amide.

"A 57-year-old white male physician was seen at my office on July 23, 1950, complaining of cardiac irregularity, a tugging sensation in the throat and epigastrium, together with mild dyspnea of several days' duration. . . . Procaine amide hydrochloride, 50 mg., was administered orally. Within 20 minutes the pulse became regular and remained so for about two hours, after which time the cardiac irregularity (ventricular extrasystoles) recurred, but less frequently. During this interim there occurred itching, burning of the palms of both hands and soles of both feet, together with angioneurotic edema. The itching became intolerable and within 30 minutes following the administration of procaine amide hydrochloride giant urticarial wheals also occurred over the skin of the back. Chlorcyclizine (perazil) hydrochloride, 100 mg., was administered in one dose orally, and Thephorine. . . . Ointment was applied locally to the involved areas of the skin. Total amelioration of the allergic symptoms occurred within one hour. Normal cardiac rhythm returned in one week. No fever occurred; eosinophil count was refused by the patient."

Bornstein, M.; Yorburg, L., and Johnston, B.: N-allylnormorphine in treatment of methorphinan (dromoran) hydrobromide poisoning. J.A.M.A. **151**: 908-910 (March 14) 1953.

"Two cases of methorphinan (dromoran) hydrobromide poisoning are reported, both of which dramatically demonstrated that N-allylnormorphine ('nalline') is a potent and rapidly acting antidote to the toxic effects of methorphinan hydrobromide. The specific action of N-allylnormorphine suggests its use in the elimination of the narcotic element in complicated medical problems of respiratory difficulty."

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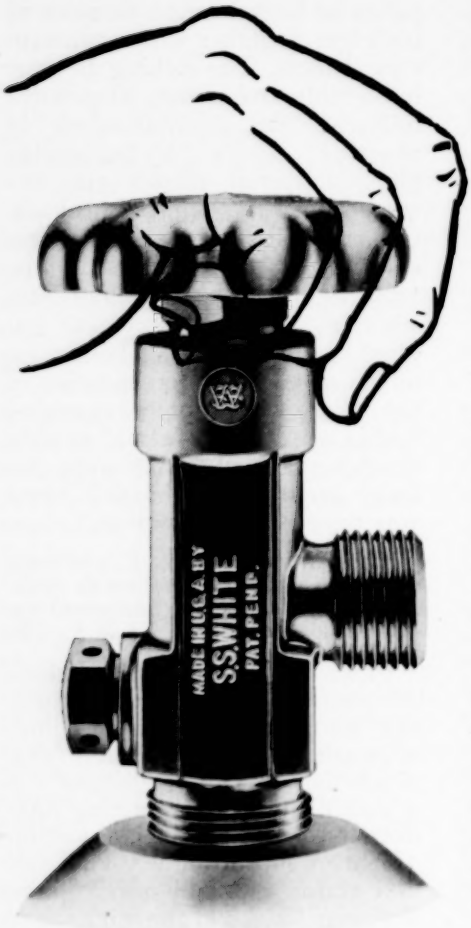

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Book Reviews

Operating Room Technic. St. Mary's Hospital, Rochester, Minnesota. Ed. 4. Cloth. 345 pages, 219 illustrations. Philadelphia: W. B. Saunders Co., 1952.

This fourth edition of a well-known text has been rewritten to include the many recent advances in technic. Primarily designed for use by nurses and assistants, anesthetists will find much useful information in this book. A study of the technics and of the many illustrations will give a better understanding of the problems of the operating team and thus increase the anesthetist's value as a member of that team.

Effective Inhalation Therapy. By Edwin Rayner Levine, M.D., Chairman of the Committee on Physiologic Therapy, American College of Chest Physicians; formerly Director of the Chest Service, Michael Reese Hospital, Chicago; Alvan L. Barach, M.D., Clinical Professor of Medicine, College of Physicians and Surgeons, Columbia University; Associate Attending, Presbyterian Hospital, New York; J. Winthrop Peabody, M.D., Professor of Diseases of the Respiratory System, Georgetown University Medical School, Washington, D. C., and Maurice S. Segal, M.D., Clinical Professor of Medicine, Tufts College Medical School, Boston; Director of the Department of Inhalation Therapy, Boston City Hospital. Cloth, 157 pages, illustrated. Chicago: National Cylinder Gas Co., 1953. $4.50.

This book is a compilation of many of the conditions in which the pressure of oxygen in the tissues of the body are diminished. Each of the conditions is the subject of a brief chapter with colored drawings to help describe the physiologic basis for the problem, and the result of treatment with therapeutic gases. The text is simply stated. The book is designed to increase the understanding of inhalation therapy by physicians, nurses and technicians. Five chapters are devoted to apparatus and technics. Here the principles are well defined. A glossary concludes the text. There is no bibliography or index.

Problems in Solution and Dosage. By Stella Goostray, B.S., M.Ed., R.N., Director Emeritus, The Children's Hospital School of Nursing, Boston, Mass. Ed. 2. 266 pages. New York: The Macmillan Co., 1952. $3.00.

Problems of arithmetic as it applies to nursing are presented in this book. Space is provided for working the problems and pages are perforated for ease of removal. This book could be useful in teaching student anesthetists by assigning lessons for self study.

Hypnosis in Modern Medicine. By Jerome M. Schneck, M.D., Clinical Associate in Psychiatry, College of Medicine, State University of New York; Psychiatric Consultant, Westchester County Department of Health (N.Y.); Founder and President, The Society for Clinical and Experimental Hypnosis. Cloth, 323 pages. Springfield, Ill.; Charles C Thomas, Publisher, 1953. $7.50.

Although this book has the name of one author, it is a collection of the writings of eleven. Each phase of medicine in which hypnosis has been used to a considerable extent has been presented by specialists with experience in hypnosis investigations. A chapter on the history of hypnosis in medicine precedes chap-

(*Continued on page 296*)

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1. *DeBakey, M.E., and others: Treatment of wound shock, in Symposium on Shock, Washington D.C., Army Medical Service Graduate School, May, 1951.*

Classified Advertisements

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WANTED: One registered nurse anesthetist for 114 bed hospital, Marietta, Georgia. Write or call Kennestone Hospital, Marietta, Ga.

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NURSE ANESTHETIST wanted for 65 bed hospital; well equipped; 155 miles north of Milwaukee; lovely vacation land; cooperative medical staff and personnel. $450 a month starting salary with partial maintenance, Blue Cross hospital insurance and Social Security. Write: Shawano Municipal Hospital, Shawano, Wis.

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WANTED: Office anesthetist to give intravenous anesthesia for oral surgery. Dr. Leon Schwartz, 608 Tampa St., Tampa 2, Fla.

ANESTHETISTS: A.A.N.A. members. 250 bed general hospital; salary open; automatic increases; laundry provided; forty hour week; no obstetrics; liberal vacation and personnel policy; Social Security. Sutter Hospital, Sacramento, Calif.

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REGISTERED NURSE ANESTHETIST: Modern, suburban, 230 bed hospital 30 minutes from Philadelphia, Pa. Department directed by medical anesthesiologist. $365 per month plus laundry. May live in, very reasonable, or out. Surgery schedule usually completed by noon. On call five weekdays, one week end per month and have each following day off. Week ends off: two at Friday, one Saturday noon. Month vacation. Wilmington General Hospital, Wilmington, Del.

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WANTED: Nurse anesthetist, salary open. Contact personnel officer, Evangelical Hospital, Chicago, Ill.

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WANTED: Registered nurse anesthetist for oral surgery office. 40 hour week 8:30 to 5:00, salary open. Write Dr. Leonard Z. Lyon, 3875 Wilshire Blvd., Los Angeles 5, Calif.

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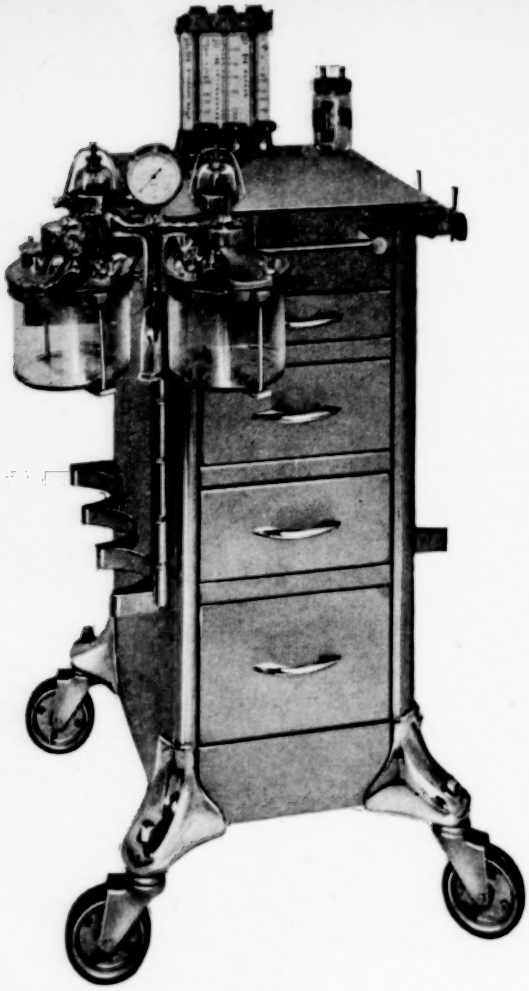

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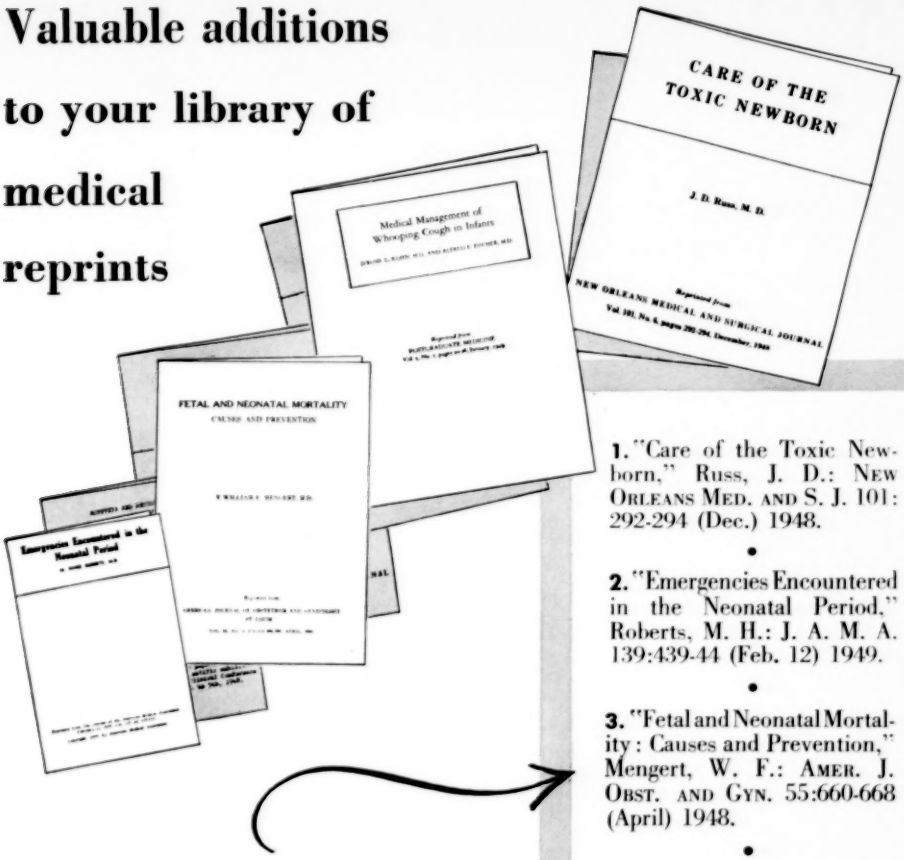
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